JULY 25, 1983

CHEMICAL & ENGINEERING

NEWS

Facts & Figures for Chemical R&D

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Cover: Deborah Haitko, chemist at GE's R&D center, Schenectady, N.Y., works on polyphenylene oxide polymerization process.

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CHEMICAL & ENGINEERING NEWS

JULY 25, 1983

News of the Week

■ **Earnings at most U.S. chemical companies are beginning to show marked improvement.** **Page 6**

■ **Michigan nuclear power plant loses its biggest customer as Dow quits pact.** **Page 7**

■ **Guayule's rubber output doubled in experiments by treatment with bioregulator.** **Page 7**

■ **Two petition candidates for president-elect are added to ACS roster for fall elections.** **Page 7**

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Chemical consulting is now reviving as a force in industry planning through outside research and is undergoing transformation. **Page 9**

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Fiscal 1984 federal budgets allow increases in funding levels for the National Science Foundation, among others. **Page 14**

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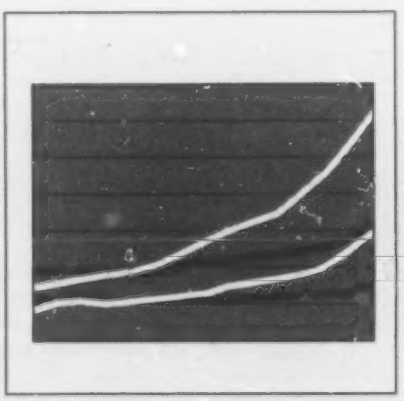
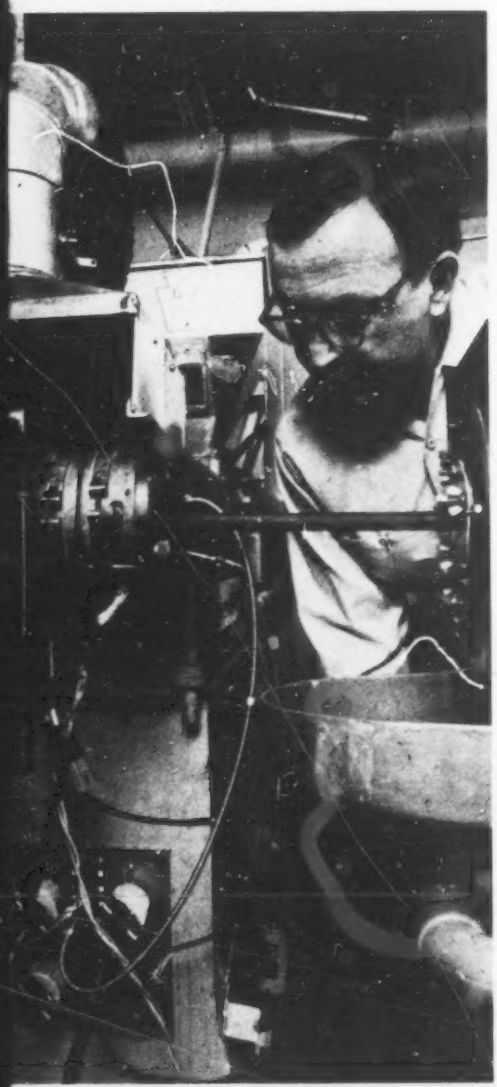


Special Report

Outpacing inflation, chemical R&D expenditures in the U.S. continue a steady upward trend, notably in industry. **Page 20**

Facts & Figures for Chemical R&D



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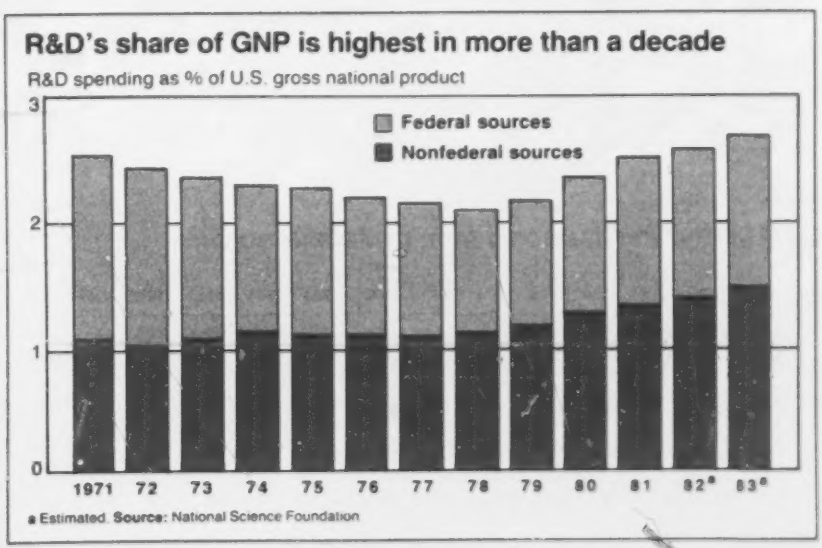
U.S. spending for research and development continues its upward trend, increasing 9% this year to $86.5 billion, according to estimates of the National Science Foundation. Even when inflation is taken into account, R&D spending actually will grow an estimated 4%. That's better than last year's 3% growth in constant dollars, although it falls short of the 5%-a-year increase, in real terms, between 1978 and 1981. The poorest year for R&D of the past decade was 1975, when spending in constant dollars declined 2%.

The best gain this year is expected on the development end of the overall R&D budget, which accounts for 65% of the total and is estimated to rise 5%, after adjustment for inflation. Basic and applied research are both slated for increases of only 3%.

The composition and character of this spending is depicted by the data reported on the following pages of C&EN's fifth annual survey of R&D spending and manpower in the U.S., with emphasis on chemistry and chemical engineering. Information is presented on where R&D funds come from, what types of R&D are being carried out, and who does the work.

One way to gauge the level of a nation's expenditures for R&D is to look at it as a percentage of gross national product. The percentage in the U.S. is expected to rise to nearly 2.7% in 1983, up from 2.6% last year. In



1964, spending for R&D reached a high of 3.0% of GNP, then graduaily decreased to 2.2% in 1978. Since then, however, it has risen every year.

The increase largely has reflected the relative growth in funds from sources outside the federal government, more than 90% of which are accounted for by private industry. Funds from nonfederal sources will edge above 1.4% of GNP this year, according to NSF, up from 1.1% five years ago and just under that level 10 years ago. On the other hand, funds from federal sources will be 1.2% of GNP this year, up from 1.1% in 1978 but slightly below the level in 1973.

Federal support of R&D is likely to rise 8% this year, which works out to a gain of just 3% in real terms. And nearly all that gain stems from the increased focus on defense spending. The defense-related segment of the federal R&D budget has climbed from 47% of the total in 1980 to 59% of the total this year, whereas civilian-related work (excluding space R&D) has dropped from 38% to 26% of the total. One agency that has seen its R&D funding shrink markedly in recent years is the Department of Energy, which the Administration has talked of abolishing.

Meanwhile, industry is increasing its spending 11%—5% after adjustment for inflation—in 1983, exclusive of federally supplied R&D funds. During the past five years, industry funding of R&D has climbed at an average annual rate of more than 6% a year, in constant dollars, but government support has risen less than 3% a year.

In U.S. universities and colleges, on the other hand, where most basic research is undertaken, growth essentially has stagnated. Spending this year, including money from industry and government, will be up a mere 1%, in real dollars, and will be less than it was two years ago. □

SECTION 1 **R&D** Overview

A gain of 7% seen in real spending for R&D next year

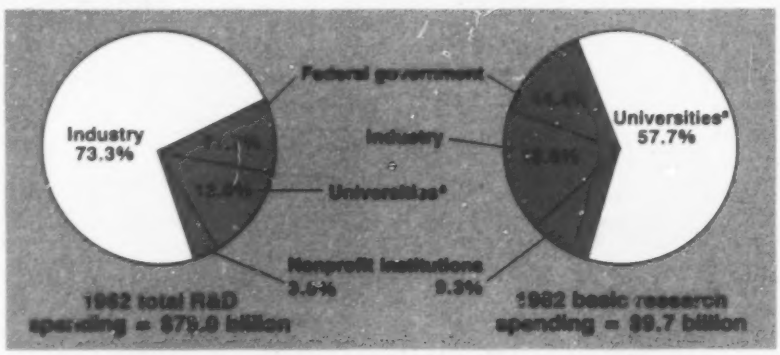
Easing of inflation means budget increases go further, as industry sets the pace in R&D funding while growth lags at universities and other nonprofit organizations

Total spending for research and development in the U.S. is expected to climb to about $97.0 billion next year, a gain of 12% over 1983, according to estimates by the National Science Foundation. When inflation is taken into account, the increase is 7%. It's been nearly 20 years since real growth in R&D has been so great. Slowing inflation is largely responsible, to be sure.

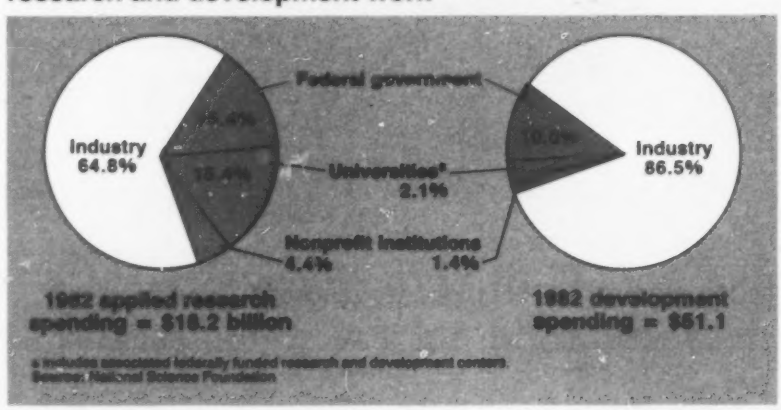
Since 1980, the chief U.S. source of R&D funds has been industrial firms; previously, the federal government was the main supplier. Universities and other nonprofit institutions are relatively minor sources. Industry's share of total R&D funding grew from 43% in 1973 to 49% in 1980 and is expected to be 51% in 1984. In the mid-1960s, nonfederal organizations of all types furnished only 35% of total R&D funds. Currently, they supply 54% and are expected to account for an even greater percentage in the years ahead.

Industry, too, is by far the major performer of R&D. In 1984, it is expected to spend $73.3 billion, 76% of total R&D outlays and a 14% increase from the previous year. Nearly a third of these outlays are funds from the federal government, but the share of industrial R&D that has federal funding has been shrinking.

Although academia does most basic research, private industry carries out the most R&D overall . . .



. . . because of industrial labs' big share of applied research and development work



TRENDS IN R&D: Since 1979, most R&D funding has come from nonfederal sources

% of total outlays	1983[a]	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	1967	1966	1965	1964
Federal	46%	46%	47%	47%	49%	50%	51%	51%	51%	51%	53%	56%	56%	57%	58%	61%	62%	64%	65%	66%
Defense related	27	25	24	22	23	24	26	26	26	27	30	32	32	33	34	35	35	33	33	37
Space related	7	7	7	7	7	7	7	8	8	8	8	8	9	10	11	13	14	19	21	19
Civilian related	12	14	16	18	19	19	18	17	17	16	15	16	15	14	13	13	13	12	11	11
Nonfederal	54	54	53	53	51	50	49	49	49	49	47	44	44	43	42	39	38	36	35	34

a Estimated. **Source:** National Science Foundation

SOURCES OF R&D FUNDS: Funding by industry shows marked increase in recent years . . .

$ Billions, current	1984[a]	1983[a]	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Federal government	$44.5	$39.6	$36.6	$33.8	$29.7	$26.9	$23.9	$21.6	$19.9	$18.1	$16.9	$16.4	8%	9%
Industry	49.8	44.3	40.0	35.9	30.8	26.1	22.5	19.6	17.7	15.8	14.9	13.3	11	13
Universities and colleges	1.7	1.6	1.5	1.5	1.3	1.2	1.0	0.9	0.8	0.7	0.7	0.6	5	10
Other nonprofit institutions	1.0	1.0	0.9	1.0	0.9	0.8	0.8	0.7	0.6	0.5	0.5	0.4	9	10
TOTAL	$97.0	$86.5	$79.0	$72.1	$62.7	$55.0	$48.2	$42.8	$39.0	$35.2	$32.9	$30.7	9%	11%

a Estimated. **Source:** National Science Foundation

. . . but support by universities and other nonprofits changed little in constant dollars

$ Billions, constant (1972)	1984[a]	1983[a]	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Federal government	$19.5	$18.1	$17.6	$17.3	$16.7	$16.4	$15.9	$15.4	$15.1	$14.5	$14.8	$15.6	3%	2%
Industry	21.8	20.3	19.3	18.4	17.2	16.0	14.9	14.0	13.4	12.6	12.9	12.6	5	5
Universities and colleges	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0	2
Other nonprofit institutions	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	3	0
TOTAL	$42.4	$39.6	$38.0	$36.9	$35.2	$33.6	$32.0	$30.5	$29.5	$28.2	$28.8	$29.2	4%	3%

a Estimated. **Source:** National Science Foundation

PERFORMERS OF R&D: Industry pushes its share of total up to 76% . . .

$ Billions, current	1984[a]	1983[a]	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Industry	$73.3	$64.3	$57.9	$51.8	$44.5	$38.2	$33.3	$29.8	$27.0	$24.2	$22.9	$21.2	11%	12%
Federal government	10.5	9.8	9.3	8.7	7.8	7.5	6.9	6.1	5.8	5.4	4.9	4.8	5	7
Universities and colleges	7.8	7.4	7.0	6.8	6.1	5.4	4.6	4.1	3.7	3.4	3.0	2.9	6	10
Associated FFRDCs[b]	2.7	2.6	2.5	2.5	2.2	1.9	1.7	1.4	1.1	1.0	0.9	0.8	2	13
Other nonprofit institutions	2.7	2.5	2.4	2.3	2.2	2.0	1.7	1.5	1.4	1.3	1.2	1.0	6	10
TOTAL	$97.0	$86.5	$79.0	$72.1	$62.7	$55.0	$48.2	$42.8	$39.0	$35.2	$32.9	$30.7	9%	11%

a Estimated. b Federally funded research and development centers administered by universities and colleges. **Source:** National Science Foundation

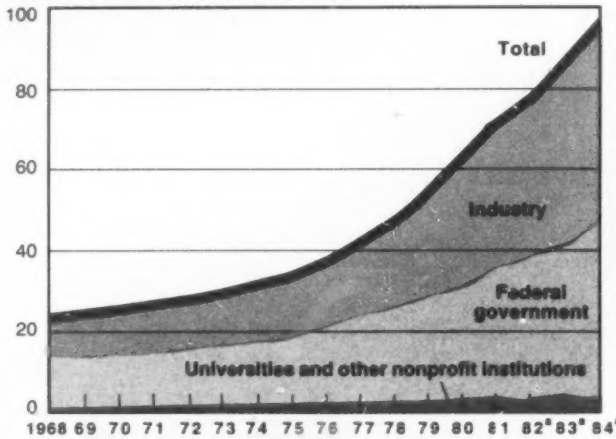
. . . as it makes the only noticeable gain recently after adjustment for inflation

$ Billions, constant (1972)	1984[a]	1983[a]	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Industry	$32.0	$29.5	$27.9	$26.5	$24.9	$23.4	$22.1	$21.3	$20.4	$19.2	$19.9	$20.1	6%	4%
Federal government	4.6	4.4	4.4	4.5	4.4	4.6	4.6	4.3	4.4	4.3	4.4	4.6	0	−1
Universities and colleges	3.4	3.4	3.4	3.5	3.4	3.3	3.1	2.9	2.8	2.8	2.7	2.8	1	2
Associated FFRDCs[b]	1.2	1.2	1.2	1.3	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.8	−3	4
Other nonprofit institutions	1.2	1.1	1.1	1.2	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1	1
TOTAL	$42.4	$39.6	$38.0	$36.9	$35.2	$33.6	$32.0	$30.5	$29.5	$28.2	$28.8	$29.1	4%	3%

a Estimated. b Federally funded research and development centers administered by universities and colleges. **Source:** National Science Foundation

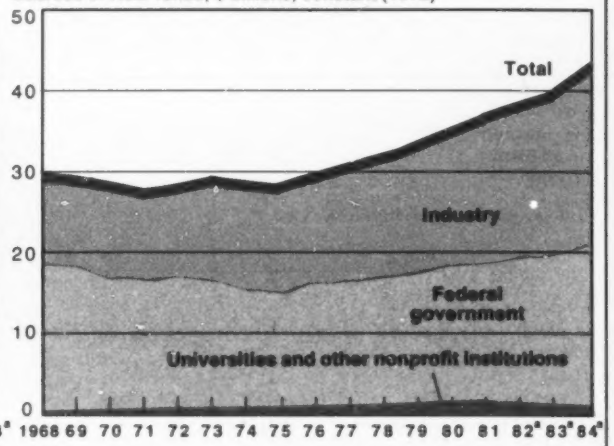
Spending for R&D has continued to climb during past 15 years . . .

Sources of R&D funds, $ billions, current



. . . with increases since 1975 having more than matched inflation

Sources of R&D funds, $ billions, constant (1972)



a Estimated. **Source:** National Science Foundation

CHARACTER OF R&D: Spending on development will rise most in 1983 . . .

$ Billions, current	1983[a]	1982[a]	1981[a]	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Basic research	$10.5	$ 9.7	$ 9.2	$ 8.1	$ 7.3	$ 6.4	$ 5.5	$ 5.0	$ 4.6	$ 4.2	$ 3.9	8%	5%
Applied research	19.7	18.2	16.9	14.1	12.4	10.8	9.7	9.0	7.9	7.2	6.6	8	12
Development	56.3	51.1	46.1	40.6	35.4	31.0	27.5	25.0	22.7	21.4	20.2	10	11

a Estimated. **Source:** National Science Foundation

. . . but inflation offsets half the gain

$ Billions, constant (1972)	1983[a]	1982[a]	1981[a]	1980	1979	1978	1977	1976	1975	1974	1973	Annual change 1982–83	Annual change 1973–83
Basic research	$ 4.8	$ 4.7	$ 4.7	$ 4.5	$ 4.4	$ 4.2	$ 3.9	$ 3.8	$ 3.7	$ 3.8	$ 3.8	3%	2%
Applied research	9.0	8.8	8.6	7.9	7.6	7.2	6.9	6.8	6.3	6.3	6.3	3	4
Development	25.8	24.6	23.6	22.7	21.6	20.6	19.7	18.9	18.1	18.7	19.1	5	3

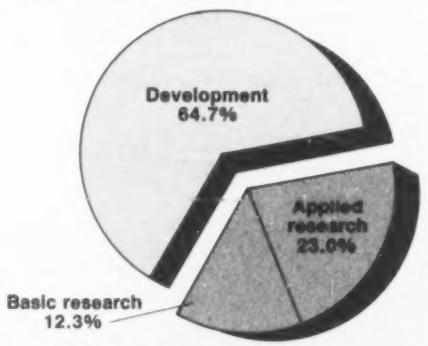
a Estimated. **Source:** National Science Foundation

EMPLOYED SCIENTISTS AND ENGINEERS: Chemists account for 9% of all scientists

Thousands	1981[a]	1980	1978	1976	1974
Physical scientists	**229.5**	**223.2**	**212.4**	**227.4**	**201.4**
Chemists	147.6	143.3	143.7	150.4	133.5
Physicists/ astronomers	60.0	59.9	51.2	58.6	52.7
Engineers	**1479.4**	**1412.1**	**1268.4**	**1240.7**	**1212.6**
Chemical	79.4	73.4	62.0	na	na
Other scientists	**1425.2**	**1275.2**	**992.4**	**909.1**	**834.2**
TOTAL	**3134.1**	**2910.5**	**2473.2**	**2377.2**	**2248.2**

a Estimated. na = not available. **Source:** National Science Foundation

Development work takes nearly two thirds of total R&D spending



1982 total R&D spending = $79.0 billion

Source: National Science Foundation

ABSTRACTS OF PAPERS IN CHEMICAL ABSTRACTS: Most active area is biochemistry

% IN EACH GROUP	1982	1981	1980	1979	1978	1977	1976	1975	1974
Biochemistry	39.5%	39.0%	39.8%	38.8%	38.3%	37.9%	38.8%	39.4%	36.2%
Physical, inorganic, and analytical chemistry	28.5	28.0	28.6	28.9	27.4	27.9	27.5	29.6	29.7
Applied chemistry and chemical engineering	19.5	19.1	18.9	19.4	20.8	19.7	18.8	15.5	18.4
Organic chemistry	7.2	8.7	7.4	7.6	8.0	8.8	8.7	9.0	9.4
Macromolecular chemistry	5.3	5.2	5.3	5.3	5.5	5.7	6.2	6.5	6.3
% OF ALL BIOCHEMISTRY ABSTRACTS									
Mammalian biochemistry[a]	11.6%	15.6%	16.3%	17.1%	17.2%	17.7%	16.3%	15.3%	16.6%
Pharmacology	12.0	12.4	12.0	11.9	12.3	12.0	12.0	12.0	11.1
Toxicology	8.1	8.7	8.3	7.4	7.5	6.2	6.4	6.6	5.6
General biochemistry	6.0	7.5	6.6	7.0	6.5	7.0	7.1	7.5	7.3
Enzymes	5.9	5.9	6.2	6.4	5.7	6.1	6.4	7.4	6.4
Others	56.4	49.9	50.6	50.2	50.8	51.0	51.8	51.2	53.0
% OF ALL PHYSICAL, INORGANIC, AND ANALYTICAL CHEMISTRY ABSTRACTS									
Nuclear chemistry	22.6%	21.6%	23.2%	25.1%	20.7%	21.1%	19.7%	20.0%	15.8%
Spectra	17.2	18.0	18.2	17.0	17.0	18.1	17.8	17.2	18.2
Electric phenomena	10.5	11.0	11.2	11.4	10.9	10.5	10.5	10.3	11.4
Crystallography and liquid crystals	8.7	8.9	8.1	8.2	9.2	8.9	9.7	9.6	10.1
General physical chemistry	7.3	7.2	7.1	6.6	6.6	6.8	7.0	6.8	6.4
Analytical chemistry	5.4	5.8	5.6	5.6	7.2	5.8	6.6	6.1	7.4
Others	28.3	27.5	26.6	25.8	28.4	28.8	28.7	30.0	30.7
% OF ALL APPLIED CHEMISTRY AND CHEMICAL ENGINEERING ABSTRACTS									
Metals and alloys	22.2%	17.9%	22.0%	23.6%	24.0%	24.2%	27.8%	24.4%	27.9%
Water, wastes, and pollution	21.7	24.0	22.5	20.8	20.8	23.2	18.6	15.2	18.2
Mineralogical and geological chemistry	13.6	14.1	15.7	15.8	16.8	13.4	17.6	17.5	17.6
Fossil fuels, derivatives, and related products	9.4	9.4	8.9	7.8	8.2	9.2	6.0	9.8	4.0
Unit operations and processes	6.9	6.4	6.0	6.1	6.4	5.8	4.8	5.3	5.6
Others	26.2	28.2	24.9	25.9	23.8	24.2	25.2	27.8	26.7
% OF ALL ORGANIC CHEMISTRY ABSTRACTS									
Physical organic chemistry	31.5%	37.0%	38.8%	38.8%	36.8%	41.3%	38.4%	40.8%	37.3%
Heterocyclic compounds[a]	15.6	16.2	17.3	16.0	17.5	17.0	17.4	16.4	17.3
Organometallic and organometalloidal compounds[a]	14.8	8.3	8.2	8.5	8.9	8.5	8.7	8.4	8.2
Aromatic compounds[a]	7.2	8.7	7.8	8.2	8.6	8.5	8.0	8.7	9.4
Aliphatic compounds[a]	5.2	6.6	6.0	6.0	6.9	5.9	6.5	6.3	7.1
Carbohydrates	5.8	5.4	5.7	6.0	5.2	4.6	5.1	4.9	5.5
Others	19.9	15.8	16.2	16.5	16.1	14.2	15.9	14.5	15.2
% OF ALL MACROMOLECULAR CHEMISTRY ABSTRACTS									
Synthetic high polymers	34.7%	30.3%	27.0%	26.3%	25.6%	26.5%	28.3%	30.6$	30.6%
Plastics manufacture and uses	21.9	26.4	28.1	27.8	28.1	27.5	26.8	23.3	23.1
Cellulose, lignin, paper, and other wood products	9.7	10.1	10.9	11.1	10.6	10.0	9.1	9.2	9.2
Textiles	8.9	9.9	10.1	10.1	12.1	11.0	11.1	10.2	9.8
Coatings, inks, and related products	7.6	7.5	7.4	8.1	7.5	7.5	7.6	7.3	8.1
Synthetic elastomers and natural rubber	7.8	7.9	8.4	7.6	8.0	8.5	8.6	9.2	10.4
Others	9.4	7.9	8.1	9.0	8.1	9.0	8.5	10.2	8.8

a Definition of section content changed in 1982. Source: Chemical Abstracts Service

U.S. PATENTS: Number granted to U.S. residents dropped more than those to foreigners in 1982

	1982	1981	1980	1979[a]	1978	1977	1976	1975	1974	1973	1972
U.S.[b]	33,896	37,356	37,152	30,605	40,979	41,383	44,162	46,603	50,643	51,501	51,515
Foreign[c]	23,993	24,463	24,675	18,248	25,123	23,886	26,074	25,291	25,632	22,638	23,293
TOTAL	57,889	61,819	61,827	48,853	66,102	65,269	70,238	71,994	76,275	74,139	74,808
% Foreign	41.4%	39.6%	39.9%	37.4%	38.0%	36.6%	37.1%	35.3%	33.6%	30.5%	31.1%

a Patent figures were low in 1979 because the Patent & Trademark Office was short of funds to print patents it might otherwise have issued. b U.S. patents granted to U.S. residents. c U.S. patents granted to residents of foreign countries. Source: Patent & Trademark Office

Military work accounts for most federal R&D growth

Chemical research is getting less federal support in fiscal 1983, reflecting cutbacks for energy and environmental work

FEDERAL OBLIGATIONS FOR R&D: Defense and space account for nearly three quarters

Department or agency	Total R&D ($ millions)				
	1983[a]	1982[a]	1981	1980	1979
Agriculture	**$ 838.9**	**$ 807.4**	**$ 774.0**	**$ 687.6**	**$ 663.0**
Agricultural Research Service	454.5	412.0	394.1	351.8[b]	345.8[b]
Cooperative State Research Service	223.3	221.2	199.4	184.2[c]	172.6[c]
Commerce	**234.7**	**280.9**	**328.0**	**342.5**	**309.4**
National Bureau of Standards	80.3	90.3	82.5	76.2	67.8
Defense	**24,519.6**	**20,602.3**	**16,508.6**	**13,981.0**	**12,506.2**
Air Force	11,405.0	9,355.8	6,969.2	5,211.0	4,525.6
Army	4,594.3	3,702.2	3,244.2	2,980.0	2,768.7
Navy	6,251.4	5,820.2	5,006.0	4706.1	4,335.0
Energy	**3,944.2**	**4,583.5**	**4,918.2**	**4,753.7**	**4,638.8**
Environmental Protection Agency	**229.9**	**317.1**	**235.7**	**345.0**	**410.1**
Health & Human Services	**4,117.8**	**3,967.9**	**3,927.1**	**3,780.2**	**3,504.9**
National Institutes of Health	3,534.6	3,428.7	3,333.2	3,181.8	2,953.1
Interior	**364.7**	**403.4**	**427.1**	**411.3**	**405.8**
National Aeronautics & Space Administration	**6,512.9**	**5,841.3**	**5,406.6**	**5,084.1**	**4,411.0**
National Science Foundation	**1,025.1**	**959.6**	**961.6**	**881.8**	**807.9**
Tennessee Valley Authority	**74.2**	**81.7**	**68.9**	**80.1**	**38.4**
Others	**1,111.8**	**1,109.0**	**1,271.6**	**1333.1**	**1,282.2**
TOTAL	**$42,973.8**	**$38,954.1**	**$34,917.4**	**$31,680.4**	**$28,977.7**

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. Note: Fiscal years. Source: National Science Foundation

FEDERAL OBLIGATIONS FOR RESEARCH: Biggest share is for health and defense

Department or agency, $ millions	1983[a]		1982[a]		1981		1980		1979	
	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research	Basic research	Applied research
Agriculture	**$ 359.1**	**$ 449.1**	**$ 332.1**	**$ 443.3**	**$ 314.1**	**$ 426.9**	**$ 275.7**	**$ 381.8**	**$ 256.4**	**$ 375.5**
Agricultural Research Service	221.6	206.7	196.1	189.6	186.4	181.5	157.8[b]	170.8[b]	148.2[b]	172.7[b]
Cooperative State Research Service	96.4	126.9	91.9	129.3	83.9	115.5	75.2[c]	109.0[c]	70.5[c]	102.1[c]
Commerce	**17.8**	**168.3**	**17.5**	**202.4**	**16.2**	**233.2**	**15.9**	**238.5**	**11.9**	**207.6**
National Bureau of Standards	17.3	54.7	16.9	55.0	15.6	50.6	12.8	46.1	8.8	43.0
Defense	**782.1**	**2543.9**	**674.2**	**2208.9**	**604.3**	**1996.6**	**540.3**	**1721.4**	**471.5**	**1542.6**
Air Force	164.2	542.0	140.4	452.0	125.8	491.5	108.2	429.1	105.0	387.2
Army	203.6	505.0	167.1	416.4	148.1	388.4	132.2	347.1	115.0	333.6
Navy	305.0	546.3	280.0	490.6	238.0	460.0	214.9	396.2	192.1	375.2
Energy	**738.7**	**760.4**	**646.8**	**895.5**	**586.3**	**827.3**	**523.1**	**754.2**	**463.0**	**668.9**
Environmental Protection Agency	**9.8**	**150.0**	**14.7**	**201.9**	**10.5**	**207.8**	**13.6**	**231.5**	**10.1**	**248.9**
Health & Human Services	**2042.3**	**1660.9**	**1970.7**	**1583.5**	**1900.4**	**1591.9**	**1762.7**	**1570.1**	**1576.0**	**1439.7**
National Institutes of Health	1896.7	1249.6	1839.4	1207.7	1766.8	1181.5	1642.3	1145.1	1463.7	1066.4
Interior	**67.6**	**251.0**	**74.2**	**275.7**	**80.7**	**289.2**	**71.6**	**282.8**	**72.5**	**266.9**
National Aeronautics & Space Administration	**677.2**	**854.5**	**575.3**	**809.5**	**531.1**	**876.0**	**559.1**	**1050.5**	**512.8**	**938.4**
National Science Foundation	**975.6**	**49.6**	**910.8**	**48.8**	**896.6**	**58.9**	**815.2**	**58.4**	**733.3**	**66.8**
Tennessee Valley Authority	**5.7**	**17.7**	**5.2**	**13.9**	**4.8**	**9.4**	**4.6**	**11.2**	**4.1**	**12.4**
Others	**89.3**	**594.3**	**89.3**	**600.7**	**96.3**	**654.3**	**92.4**	**822.8**	**81.1**	**574.6**
TOTAL	**$5765.2**	**$7499.7**	**$5310.8**	**$7284.1**	**$5041.3**	**$7171.5**	**$4674.2**	**$6923.2**	**$4192.7**	**$6342.3**

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. Note: Fiscal years. Source: National Science Foundation

FEDERAL OBLIGATIONS FOR SCIENTIFIC DISCIPLINES: Support for chemistry slips in 1983

$ Millions for research only	1983[a]	1982[a]	1981	1980	1979	Annual change 1982–83	Annual change 1979–83
Engineering	$ 3,172	$ 3,137	$ 3,072	$ 2,830	$ 2,572	1%	5%
Chemical	144	150	148	96	114	−4	4
Metallurgy and materials	314	294	256	236	249	7	6
Environmental sciences	1,098	1,093	1,121	1,261	1,101	0	−1
Life sciences	4,735	4,593	4,436	4,192	3,848	3	5
Mathematics and computer sciences	357	311	279	241	210	15	9
Physical sciences	2,846	2,510	2,221	2,001	1,793	13	12
Chemistry	533	645	487	455	444	−17	4
Physics	1,762	1,396	1,346	1,183	1,023	26	14
Other sciences	1,057	952	1,085	1,072	1,011	11	1
TOTAL	$13,265	$12,595	$12,213	$11,597	$10,535	5%	6%

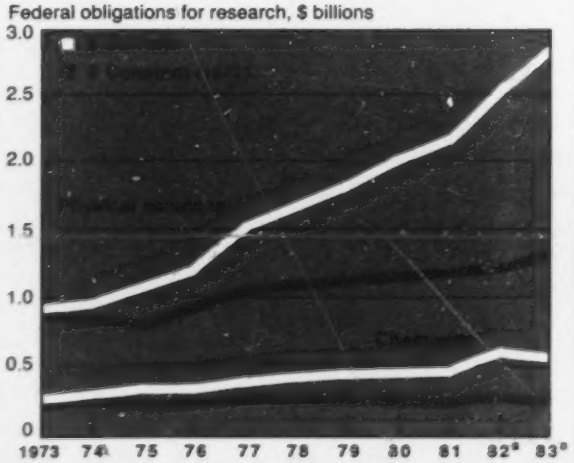
a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

FEDERAL OBLIGATIONS FOR DEVELOPMENT: About 70% goes for defense

Department or agency	Development ($ millions) 1983[a]	1982[a]	1981	1980	1979
Agriculture	$ 30.7	$ 32.0	$ 33.0	$ 30.2	$ 31.1
Agricultural Research Service	26.2	26.2	26.2	23.3[b]	24.9[b]
Cooperative State Research Service	0	0	0	0[c]	0[c]
Commerce	48.6	61.0	78.6	88.1	89.9
National Bureau of Standards	8.2	18.5	16.3	17.3	16.0
Defense	21,193.6	17,719.1	14,607.7	11,719.2	10,492.1
Air Force	10,698.8	8,783.4	6,351.9	4,673.7	4,033.4
Army	3,885.7	3,118.7	2,707.7	2,500.7	2,320.1
Navy	5,400.1	5,049.6	4,308.0	4,095.0	3,767.7
Energy	2,445.1	3,041.2	3,504.6	3,476.4	3,506.9
Health & Human Services	414.5	413.8	434.9	447.4	489.2
National Institutes of Health	388.3	381.6	384.9	394.4	423.0
Interior	46.0	53.6	57.3	56.8	66.3
Environmental Protection Agency	70.1	100.5	107.4	99.9	151.1
National Aeronautics & Space Administration	4,981.2	4,456.5	3,999.4	3,474.4	2,959.8
National Science Foundation	0	0	6.1	8.1	7.9
Tennessee Valley Authority	50.8	62.6	54.7	64.3	21.9
Others	428.3	418.8	520.9	618.2	626.5
TOTAL	$29,708.9	$26,359.1	$22,704.6	$20,083.0	$18,442.7

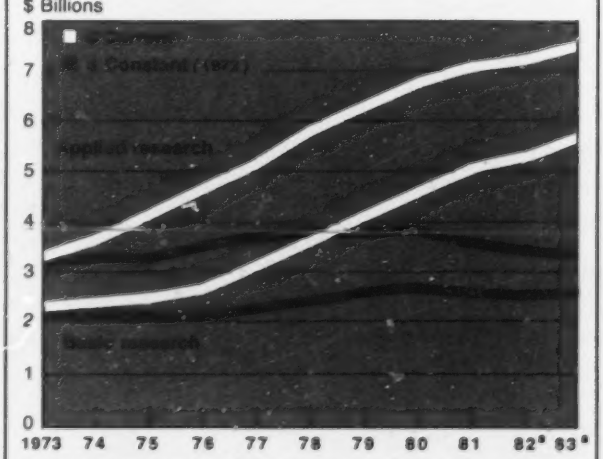
a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. **Note:** Fiscal years. **Source:** National Science Foundation

Chemistry accounts for a fifth of federal funding for physical science research



a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

Government support of research, in real terms, little changed in recent years



a Estimated. **Note:** Fiscal years **Source:** National Science Foundation

BASIC RESEARCH: NSF and Energy Department remain major backers for chemistry

Department or agency	Federal obligations ($ millions)									
	1983[a]		1982[a]		1981		1980		1979	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 40.5	$ 38.7	$ 36.9	$ 35.1	$ 33.7	$ 31.8	$ 25.8	$ 24.0	$ 23.8	$ 22.3
Agricultural Research Service	34.4	33.2	30.5	29.4	27.7	26.5	20.8[b]	19.6[b]	20.0[b]	18.2[b]
Cooperative State Research Service	3.7	3.7	3.8	3.8	3.4	3.4	3.0[c]	3.0[c]	2.8[c]	2.8[c]
Commerce	14.6	4.6	14.5	5.1	12.6	2.9	11.3	2.2	7.9	1.6
National Bureau of Standards	14.6	4.6	14.5	5.1	12.6	2.9	11.0	2.1	7.9	1.5
Defense	208.4	59.8	180.9	48.4	194.9	43.5	187.1	35.7	119.4	26.6
Air Force	42.1	19.8	34.5	14.1	32.3	12.9	24.8	10.4	24.0	10.0
Army	60.4	20.0	51.7	16.7	49.5	14.5	46.0	12.7	9.7	4.3
Navy	101.3	20.0	91.5	17.6	79.7	15.9	71.9	12.3	43.6	10.1
Energy	619.6	86.6	531.7	78.9	480.2	70.0	432.1	62.1	345.6	57.7
Environmental Protection Agency	2.6	2.6	5.3	5.3	2.9	2.9	2.3	2.3	1.8	1.8
Health & Human Services	57.8	52.1	55.9	50.4	53.2	48.0	53.7	47.4	40.7	36.7
National Institutes of Health	56.7	51.1	55.0	49.5	52.8	47.6	53 0	46.6	40.3	36.3
Interior	8.1	5.5	8.6	5.8	10.1	6.8	7.5	5.3	9.1	6.5
Geological Survey	2.6	1.8	2.8	1.9	3.0	2.0	2.6	1.7	2.6	1.7
National Aeronautics & Space Administration	404.4	5.5	316.4	4.1	268.9	6.6	309.0	5.2	292.5	5.3
National Science Foundation	282.0	89.6	268.8	85.4	254.8	81.5	198.6	68.4	197.1	60.3
Tennessee Valley Authority	3.7	3.7	3.4	3.4	3.1	3.1	3.1	3.1	2.7	2.7
Others	8.7	0	9.6	0.7	10.5	1.1	10.1	1.2	9.4	1.3
TOTAL	$1650.4	$348.7	$1432.0	$322.6	$1324.9	$298.2	$1220.6	$256.9	$1050.0	$224.8

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. **Note:** Fiscal years. **Source:** National Science Foundation

APPLIED RESEARCH: Chemistry this year gets lower share of funds for physical sciences

Department or agency	Federal obligations ($ millions)									
	1983[a]		1982[a]		1981		1980		1979	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 27.5	$ 25.6	$ 26.4	$ 24.5	$ 25.0	$ 22.7	$ 26.9	$ 24.9	$ 26.9	$ 25.0
Agricultural Research Service	19.0	17.6	17.4	16.1	16.2	14.6	20.0[b]	17.8[b]	19.3[b]	18.1[b]
Cooperative State Research Service	6.3	6.3	6.5	6.5	5.8	5.8	5.4[c]	5.4[c]	5.1[c]	5.1[c]
Commerce	31.3	8.4	30.1	7.7	30.5	8.9	27.4	7.3	27.8	7.3
National Bureau of Standards	25.0	7.5	24.1	6.8	24.4	7.5	21.3	6.0	21.9	6.1
Defense	599.3	68.2	506.7	62.5	335.2	47.2	243.4	42.5	237.0	59.5
Air Force	55.7	14.2	50.1	13.0	49.7	14.3	41.5	12.5	91.0	19.6
Army	78.9	38.4	75.7	37.6	58.6	24.6	54.3	24.2	80.6	26.8
Navy	149.9	15.3	129.2	11.6	98.5	8.1	59.0	5.3	62.6	6.2
Energy	451.9	16.1	407.8	137.3	390.2	13.7	380.0	22.2	317.7	14.6
Environmental Protection Agency	34.3	34.3	61.5	61.5	66.4	66.4	69.3	68.4	71.4	70.7
Health & Human Services	27.8	24.7	25.6	22.8	25.1	22.1	26.1	22.5	29.1	26.1
National Institutes of Health	26.3	23.1	25.4	22.3	24.8	21.8	25.4	21.8	28.8	25.9
Interior	5.5	4.6	5.4	4.5	7.3	5.3	6.4	4.4	6.6	5.3
Geological Survey	4.3	3.4	4.0	3.2	5.0	4.0	3.7	2.9	4.0	3.2
National Aeronautics & Space Administration	9.0	0.4	9.0	0.4	11.3	1.1	12.3	1.5	12.3	1.1
National Science Foundation	2.6	1.3	2.3	1.0	2.2	0.9	4.7	2.3	8.7	5.3
Others	6.7	0.5	3.2	0.5	2.4	0.4	3.5	1.6	5.3	3.9
TOTAL	$1195.9	$184.1	$1078.0	$322.5	$895.6	$188.7	$780.0	$197.6	$742.6	$218.8

a Estimated. b Agricultural R&D in Science & Educational Administration. c Cooperative R&D in Science & Education Administration. **Note:** Fiscal years. **Source:** National Science Foundation

OBLIGATIONS FOR PHYSICAL SCIENCE RESEARCH: Chemistry's share for energy work shrinks

Department or agency	Federal obligations ($ millions)									
	1983[a]		1982[a]		1981		1980		1979	
	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry	Physical sciences	Chemistry
Agriculture	$ 68.0	$ 64.3	$ 63.2	$ 59.8	$ 58.7	$ 54.5	$ 52.6	$ 48.9	$ 50.6	$ 47.2
Agricultural Research Service	53.4	50.8	47.9	45.5	43.9	41.1	40.8[b]	37.4[b]	39.3[b]	36.3[b]
Cooperative State Research Service	10.0	10.0	10.2	10.2	9.2	9.2	8.4[c]	8.4[c]	7.9[c]	7.9[c]
Commerce	45.9	13.0	44.5	12.8	43.1	11.8	38.7	9.5	35.5	8.9
National Bureau of Standards	39.6	12.1	38.5	11.9	37.0	10.4	32.3	8.7	29.8	7.7
Defense	607.7	128.0	587.6	110.9	530.1	90.7	410.5	78.2	356.4	88.1
Air Force	97.8	33.9	84.5	27.2	82.1	27.2	66.3	22.9	120.1	29.6
Army	139.3	58.5	127.4	54.3	108.0	39.1	100.3	36.9	90.2	41.0
Navy	251.2	35.4	220.6	29.2	178.2	24.0	131.0	17.6	106.2	16.2
Energy	1071.5	102.7	939.5	216.2	870.4	83.7	792.1	84.3	663.4	72.3
Environmental Protection Agency	36.9	36.9	66.8	66.8	69.3	69.3	71.5	70.7	73.2	72.5
Health & Human Services	85.6	76.8	81.5	73.0	78.3	70.1	79.8	69.9	69.8	62.8
National Institutes of Health	83.0	74.2	80.4	71.9	77.7	69.4	78.3	68.4	69.2	62.1
Interior	13.7	10.1	14.1	10.3	17.4	12.0	13.9	9.8	15.7	11.8
Geological Survey	6.9	5.2	6.8	5.0	8.0	6.0	6.2	4.6	6.6	4.9
National Aeronautics & Space Administration	413.4	5.9	325.4	4.5	280.1	7.7	321.3	6.7	304.8	6.4
National Science Foundation	284.6	90.9	271.1	86.4	257.0	82.4	203.3	70.7	205.8	65.6
Tennessee Valley Authority	3.7	3.7	3.4	3.4	3.1	3.1	3.1	3.1	5.4	5.4
Others	15.3	0.5	13.0	1.2	13.0	1.6	13.8	2.7	12.0	2.6
TOTAL	$2546.3	$532.8	$2510.1	$645.1	$2220.5	$486.9	$2000.6	$454.5	$1792.6	$443.6

a Estimated. b Agricultural R&D in Science & Education Administration. c Cooperative R&D in Science & Education Administration. **Note:** Fiscal years. **Source:** National Science Foundation

UNIVERSITY RESEARCH: Bulk of federal money goes to life sciences

Federal obligations, $ millions	1983[a]	1982[a]	1981	1980	1979	1978	1977	Annual change 1982–83	Annual change 1977–83
Engineering	$ 392.6	$ 368.5	$ 365.3	$ 323.7	$ 269.6	$ 240.9	$ 220.6	7%	10%
Chemical	23.3	21.2	21.9	20.3	19.2	24.5	17.1	10	5
Metallurgy and materials	83.4	74.1	69.5	57.3	52.3	49.2	46.9	13	10
Environmental sciences	300.5	284.0	280.3	297.0	275.5	226.5	205.2	6	7
Life sciences	2267.7	2208.8	2117.2	1984.7	1796.0	1605.2	1399.9	3	8
Mathematics and computer sciences	168.6	141.6	121.4	94.6	87.5	79.5	72.9	19	15
Physical sciences	593.0	545.1	525.2	461.0	402.8	366.6	326.1	9	10
Chemistry	208.5	192.0	193.5	159.5	140.1	123.5	115.8	9	10
Physics	325.7	291.7	274.5	246.1	214.7	198.7	167.0	12	12
Other sciences	284.0	270.1	297.5	302.7	285.6	253.0	228.6	5	4
TOTAL	$4006.4	$3818.1	$3706.9	$3463.6	$3117.0	$2771.7	$2453.3	5%	9%

a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

UNIVERSITY BASIC RESEARCH: Chemistry's share is 7% of total federal funds

Federal obligations, $ millions	1983[a]	1982[a]	1981	1980	1979	1978	1977	Annual change 1982–83	Annual change 1977–83
Engineering	$ 278.3	$ 258.2	$ 237.3	$ 208.4	$ 164.0	$ 151.5	$ 139.3	8%	12%
Chemical	21.0	19.1	19.8	16.9	12.5	9.3	9.5	10	14
Metallurgy and materials	76.4	69.0	62.6	51.9	47.6	43.4	42.1	11	10
Environmental sciences	267.5	248.9	241.6	255.3	229.9	191.8	166.0	7	8
Life sciences	1423.2	1378.3	1314.6	1219.5	1140.1	926.9	809.8	3	10
Mathematics and computer sciences	132.8	119.4	102.6	79.8	69.0	65.3	56.6	11	9
Physical sciences	494.3	454.8	434.7	375.9	323.3	299.5	270.2	9	11
Chemistry	183.0	167.5	164.7	136.1	114.3	102.2	96.2	9	11
Physics	260.9	235.8	222.4	194.3	166.2	157.1	137.4	11	11
Other sciences	148.7	137.9	148.2	152.4	125.4	103.1	93.3	8	8
TOTAL	$2744.8	$2597.5	$2479.0	$2291.3	$2051.7	$1738.1	$1535.2	6%	10%

a Estimated. **Note:** Fiscal years. **Source:** National Science Foundation

Defense R&D budget to get a solid boost for fiscal 1984, but most NSF programs do well also

DEPARTMENT OF ENERGY R&D BUDGET: Holding its own in fiscal 1984

$ Millions	1984 Congressional appropriation	1984 Administration request	1983[a]	1982	1981	% change 1983–84
Defense R&D	$ 714.5	$ 714.5	$ 641.5	$ 584.9	$ 508.1	11.4%
Nuclear	548.8	807.3	746.2	772.4	871.7	−26.4
General science and research	475.7	479.7	423.4	423.9	378.0	12.3
Magnetic fusion	394.4	392.7	368.6	295.1	256.3	7.0
Supporting research and technical analysis	311.6	313.6	272.7	269.6	240.4	14.3
Fossil energy	265.9[b]	94.0	217.5	417.7	818.7	22.2
Environment	211.3	197.3	206.1	213.6	206.7	2.5
Solar energy	174.4	86.4	201.4	252.4	451.2	−13.4
Conservation R&D	144.0[b]	71.0	152.7	152.3	248.8	−5.7
Electric energy systems and storage	44.2	26.9	42.9	58.3	85.1	3.0
Geothermal	29.5	13.5	30.4	41.3	126.3	−3.0
TOTAL	**$3314.3**	**$3196.9**	**$3303.4**	**$3481.5**	**$4191.3**	**0.3%**

a Estimate. b Based only on House action to date **Note:** Fiscal years ending Sept. 30.

NSF BUDGET: Hefty increases for all but one program

$ Millions	1984 Congressional appropriation	1984 Administration request	1983[a]	1982	1981	% change 1983–84
Mathematical and physical sciences	$ 361.1[b]	$ 364.3	$ 299.7	$272.8	$ 256.5	20.5%
Astronomical, atmospheric, earth, and ocean sciences	328.0[b]	334.9	276.1	259.9	258.3	18.8
Biological, behavioral, and social sciences	227.3	223.6	190.2	176.6	185.5	19.8
Engineering	119.8[b]	123.0	100.8	93.3	86.4	18.8
Antarctic program	102.1	102.1	83.2	68.5	67.4	22.7
Science and engineering education	75.0	39.0	30.0	20.9	70.7	150.0
Program development and management	65.0	66.0	65.3	63.2	59.2	—
Scientific, technological and international affairs	37.8	36.8	44.2	40.3	53.8	−14.5
Special foreign currency	2.6	2.6	3.1	3.6	4.0	−16.1
TOTAL	**$1318.7**	**$1292.3**	**$1092.6**	**$999.1**	**$1041.8**	**20.7%**

a Estimate. b Reflects one-third share of $20.8 million reduction. **Note:** Fiscal years ending Sept. 30

DEFENSE R&D BUDGET: Continues its surge upward

$ Millions	1984 Probable Congressional authorization[a]	1984 Administration request	1983[b]	1982	1981	% change 1983–84
Air Force	$12,448.1	$13,652.3	$10,720.8	$ 8,659.6	$ 7,033.0	16.1%
Navy	7,629.0	8,182.4	6,129.1	5,844.4	4,974.3	24.5
Army	4,198.9	4,793.7	3,926.4	3,609.5	3,127.8	6.9
Defense agencies	2,758.5	2,996.9	2,271.5	1,745.6	1,341.0	21.4
TOTAL	**$27,034.5**	**$29,625.3**	**$23,047.8**	**$19,589.1**	**$16,526.6**	**17.3%**

a C&EN estimate based on House and Senate action to date. b Estimate. **Note.** Fiscal years ending Sept. 30.

NASA R&D BUDGET: Gets a modest 5% increase for the year ahead

$ Millions	1984 Congressional appropriation	1984 Administration request	1983[a]	1982	1981	% change 1983–84
Conduct of R&D	**$5801.8**	**$5708.5**	**$5542.8**	**$4786.9**	**$4332.4**	**4.6%**
Space transportation systems	3532.5	3498.0	3597.8	3104.8	2728.6	−1.8
Tracking and data acquisition	690.0	700.2	498.8	402.1	339.9	38.3
Physics and astronomy	564.6	514.6	441.0	322.4	323.7	28.0
Aeronautical research and technology	312.3	300.3	280.0	264.8	271.4	11.5
Space applications	292.0	289.0	351.0	324.3	331.5	−16.8
Planetary exploration	219.4	205.4	186.4	210.0	175.6	17.7
Space research and technology	138.0	138.0	123.0	111.0	110.7	12.2
Life sciences	59.0	59.0	55.7	39.5	42.2	5.9
Technology utilization	9.0	4.0	9.0	8.0	8.8	—
General reduction	−15.0	—	—	—	—	—
Research and program management	**1238.5**	**1247.5**	**1168.9**	**1183.3**	**1071.1**	**5.9**
Construction of facilities	**135.5**	**150.5**	**97.5**	**132.1**	**117.0**	**39.0**
TOTAL	**$7175.8**	**$7106.5**	**$6809.2**	**$6102.3**	**$5520.5**	**5.3%**

a Estimate. **Note:** Fiscal years ending Sept. 30.

EPA R&D BUDGET: Substantially higher than requested by the Administration

$ Millions	1984 Congressional appropriation	1984 Administration request	1983[a]	1982	1981	% change 1983–84
Air	$ 32.3	$ 27.3	$ 35.4	$ 38.4	$ 59.0	−8.8%
Solid/hazardous waste	26.3	17.0	21.2	21.9	28.3	17.4
Energy	22.0	20.0	22.4	57.6	84.1	−2.0
Interdisciplinary	16.0	16.0[b]	3.5	4.5	6.1	—
Drinking water	14.5	12.0	14.3	22.4	21.8	1.4
Toxic substances	12.9	11.9	14.2	20.9	30.0	9.1
Water quality	11.4	6.4	12.2	31.7	49.9	1.6
Pesticides	1.7	1.7	2.1	2.2	7.9	−19
Radiation	1.0	0.02	0.5	0.9	2.4	100
TOTAL	**$143.1[c]**	**$112.3**	**$125.8**	**$200.5**	**$289.5**	**13.7%**

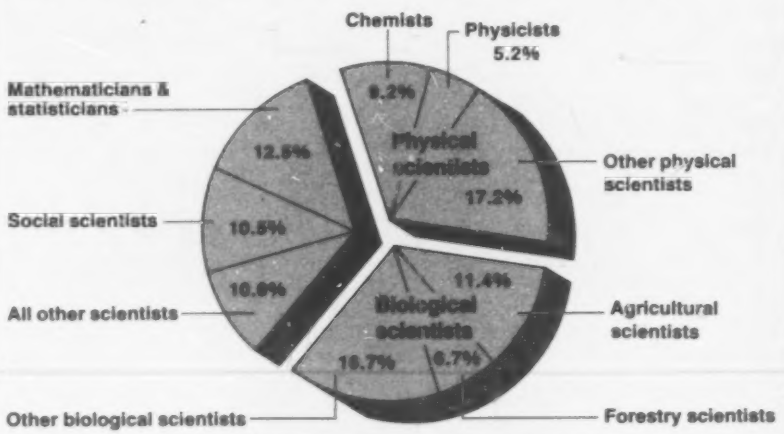
a Estimate. b Not an increase in total budget, reflects consolidation of other programs into the interdisciplinary program. c Includes $5 million to be allocated to high-priority programs at agency's discretion. **Note:** Fiscal years ending Sept. 30.

NIH BUDGET: Administration is seeking a very slight increase

$ Millions	1984[a]	1983[b]	1982	1981	1980	% change 1983–84
National Institutes	**$3769.7**	**$3689.9**	**$3392.0**	**$3306.3**	**$3044.9**	**2.1%**
Cancer	986.7	983.6	943.0	947.3	898.0	0.3
Heart, Lung & Blood	637.7	622.7	559.6	549.7	527.1	2.4
Arthritis, Diabetes & Digestive & Kidney Disease	426.4	412.2	368.2	369.5	340.1	3.4
General Medical Science	383.1	369.6	355.4	329.4	312.3	3.6
Neurological & Communicative Disorders & Stroke	301.5	295.7	265.5	252.6	214.3	1.9
Allergy & Infectious Diseases	289.4	273.6	235.8	232.2	214.7	5.7
Child Health & Human Development	256.6	253.6	226.2	220.7	208.3	1.2
Environmental Health Sciences	165.9	164.4	154.1	140.0	83.6	0.9
Eye	142.3	141.6	130.4	118.0	109.6	0.5
Aging	99.4	94.0	81.8	75.7	69.7	0.5
Dental Research	80.7	78.9	72.0	71.2	67.2	2.1
Research Resources	**201.8**	**213.8**	**184.1**	**175.7**	**169.1**	**−5.6**
National Library of Medicine	**49.6**	**47.1**	**44.8**	**44.7**	**43.9**	**5.3**
Office of the Director	**26.7**	**25.7**	**23.6**	**21.7**	**20.8**	**3.9**
Research facilities	**19.9**	**29.1**	**9.9**	**11.7**	**13.9**	**−31.6**
John E. Fogarty Center	**9.2**	**10.3**	**9.2**	**9.1**	**8.6**	**−10.7**
TOTAL	**$4076.9**	**$4015.9**	**$3663.6**	**$3589.2**	**$3301.2**	**1.5%**

a Administration request. b Estimate. **Note:** Fiscal years ending Sept. 30.

About 9% of all government scientists are chemists



1981 total federal scientists = 86, 630[a]

a As of October 1981. **Source:** National Science Foundation

SCIENTISTS AND ENGINEERS BY AGENCY: Health and defense are leading fields for chemists

Department or agency	Physical scientists	Chemists	Physicists	Engineers	Chemical engineers	Other scientists	Total scientists and engineers
Agriculture[a]	1,443	942	31	3,306	59	20,573	25,322
Commerce	3,833	335	567	748	18	2,947	7,528
Defense	8,591	1,998	3,262	56,473	726	12,653	77,717
Air Force	1,094	295	490	10,119	41	1,361	12,574
Army	3,108	874	870	20,355	390	4,656	28,119
Navy	3,885	735	1,871	24,651	290	2,674	31,210
Others	504	94	31	1,348	5	3,962	5,814
Energy	571	0	113	2,813	181	599	3,983
Environmental Protection Agency	1,632	599	17	1,618	127	894	4,144
Health & Human Services	2,157	1,999	90	473	25	4,550	7,180
Interior	5,007	457	62	3,058	73	6,908	14,973
National Aeronautics & Space Administration	1,300	80	269	8,819	20	783	10,902
Tennessee Valley Authority	245	112	0	3,922	172	376	4,543
Transportation	134	34	9	4,653	16	701	5,488
Veterans Administration	687	614	44	992	0	2,353	4,032
Others	1,775	778	37	4,039	42	5,913	11,727
TOTAL	27,375	7,948	4,501	90,914	1,459	59,250	177,539

a Estimated. **Note:** Data as of October 1981. **Source:** National Science Foundation

FEDERAL SCIENTISTS AND ENGINEERS: Number of chemists lowest since 1974

Thousands	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971
Physical scientists	27.4	27.6	27.6	27.5	27.1	27.1	26.7	26.3	26.4	27.4	30.4
Chemists	7.9	8.1	8.1	8.3	8.0	8.1	8.0	7.8	8.0	8.4	8.3
Physicists	4.5	4.6	4.9	5.0	5.1	5.3	5.4	5.5	5.6	5.8	5.4
Engineers	90.9	89.6	88.8	89.2	87.8	87.0	86.6	82.5	84.3	87.0	84.2
Chemical	1.4	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5	1.6	1.5
Other scientists	59.3	60.8	58.3	57.2	54.3	51.6	50.6	48.8	48.4	50.1	48.7
TOTAL	177.5	178.0	174.7	173.9	169.2	165.7	163.9	157.6	159.1	164.5	163.3

Note: As of October of each year. **Source:** National Science Foundation

SECTION 3 **R&D Industry**

Industrial R&D maintains rapid growth

Chemical producers have been boosting R&D spending more rapidly than industry as a whole, but this year's budgets point to a slackening pace

TOTAL FUNDS FOR INDUSTRIAL R&D: Spending is rising relatively fast in chemical industry

$ Millions	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	Annual change 1981–82	Annual change 1972–82
Chemicals and allied products	$ 6,250	$ 5,325	$ 4,636	$ 4,038	$ 3,580	$ 3,202	$ 3,017	$ 2,727	$ 2,450	$ 2,116	$ 1,832	17%	12%
Industrial chemicals	3,000	2,553	2,197	1,962	1,798	1,668	1,524	1,391	1,299	1,119	1,031	18	11
Drugs	2,400	2,022[a]	1,777	1,517	1,308	1,117	1,091	981	807	698	607	19	15
Other chemicals	850	750[a]	662	559	474	417	401	354	344	299	294	13	11
Other industries	51,600	46,505	39,869	34,188	29,724	26,623	23,980	21,460	20,437	19,133	17,620	11	11
TOTAL	$57,850	$51,830	$44,505	$38,226	$33,304	$29,825	$26,997	$24,187	$22,887	$21,249	$19,552	12%	11%

a C&EN estimates. **Source:** National Science Foundation

FEDERAL FUNDS FOR INDUSTRIAL R&D: Little support for chemical industry's labs

$ Millions	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	Annual change 1981–82	Annual change 1972–82
Chemicals and allied products	$ 425[a]	$ 383	$ 372	$ 346	$ 330	$ 295	$ 266	$ 236	$ 214	$ 203	$ 189	11%	8%
Industrial chemicals	400[a]	367	341	345	325	281	249	218	194	183	171	9	9
Drugs and other chemicals	25[a]	16	31	1	5	14	17	18	20	20	18	56	3
Other industries	18,100[a]	16,085	13,657	12,172	10,859	10,190	9295	8389	8006	7942	7828	13	9
TOTAL	$18,525	$16,468	$14,025	$12,518	$11,189	$10,485	$9561	$8605	$8220	$8145	$8017	12%	9%

a C&EN estimates. **Source:** National Science Foundation

COMPANY FUNDS FOR INDUSTRIAL R&D: Chemical firm's outlays doubled in past five years

$ Millions	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	Annual change 1981–82	Annual change 1972–82
Chemicals and allied products	$ 5,825[a]	$ 4,942	$ 4,264	$ 3,692	$ 3,250	$ 2,907	$ 2,751	$ 2,490	$ 2,238	$ 1,913	$ 1,741	18%	13%
Industrial Chemicals	2,600[a]	2,186	1,856	1,617	1,473	1,387	1,275	1,173	1,105	936	860	19	12
Drugs and other chemicals	3,225[a]	2,756	2,408	2,075	1,777	1,520	1,476	1,317	1,131	977	881	17	14
Other industries	33,500[a]	30,420	26,212	22,016	18,865	16,433	14,685	13,092	12,431	11,191	9,794	10	13
TOTAL	$39,325	$35,362	$30,476	$25,708	$22,115	$19,340	$17,436	$15,582	$14,667	$13,104	$11,535	11%	13%

a C&EN estimates. **Source:** National Science Foundation

BASIC RESEARCH IN INDUSTRY: Chemical industry does about a third of total

$ Millions	1981	1979	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968
Chemicals and allied products	**$ 539**	**$ 366**	**$337**	**$333**	**$298**	**$288**	**$236**	**$214**	**$216**	**$207**	**$208**	**$202**
Industrial chemicals	335	197	163	149	136	129	111	107	110	89	121	126
Drugs	180	143	134	129	114	107	90	78	77	93	67	60
Other chemicals	24	26	40	55	48	52	35	29	29	25	20	16
Other industries	**1102**	**792**	**574**	**484**	**431**	**411**	**395**	**379**	**374**	**395**	**410**	**440**
TOTAL	**$1641**	**$1158**	**$911**	**$817**	**$729**	**$699**	**$631**	**$593**	**$590**	**$602**	**$618**	**$642**

Note: No data for 1978 and 1980. **Source:** National Science Foundation

APPLIED RESEARCH IN INDUSTRY: For chemical firms, four times bigger than basic research

$ Millions	1981	1979	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968
Chemicals and allied products	**$ 2,263**	**$1726[a]**	**$1347[a]**	**$1226**	**$1102**	**$ 941**	**$ 841**	**$ 745**	**$ 707**	**$ 660**	**$ 666**	**$ 603**
Industrial chemicals	1,113	881[a]	605[a]	522	463	562	489	437	436	423	425	385
Drugs	na	654[a]	486[a]	472	426	266	248	206	184	167	160	144
Other chemicals	na	191[a]	256[a]	231	213	113	104	102	87	70	81	74
Other industries	**8,449**	**5499[a]**	**4289**	**3909**	**3474**	**3219**	**2898**	**2726**	**2677**	**2739**	**2621**	**2521**
TOTAL	**$10,712**	**$7225**	**$5636**	**$5135**	**$4576**	**$4160**	**$3739**	**$3471**	**$3384**	**$3399**	**$3287**	**$3124**

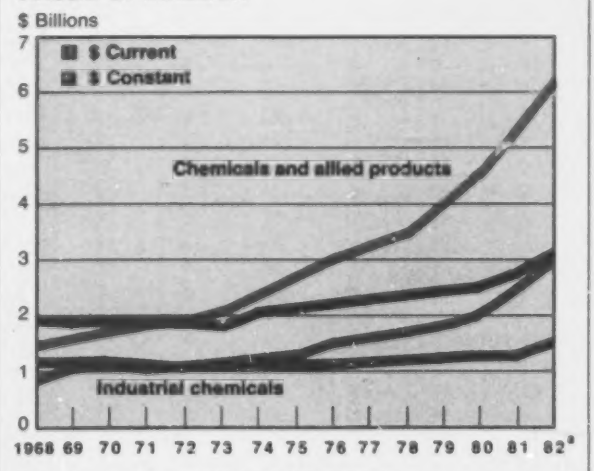
a Estimates. **Note:** No data for 1978 and 1980. **na** = not available. **Source:** National Science Foundation

DEVELOPMENT IN INDUSTRY: Accounts for largest share of total R&D funds

$ Millions	1981	1979	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968
Chemicals and allied products	**$ 2,523**	**$ 1,946[a]**	**$ 1,518**	**$ 1,472**	**$ 1,330**	**$ 1,162**	**$ 999**	**$ 945**	**$ 872**	**$ 876**	**$ 845**	**$ 841**
Industrial chemicals	1,105	947[a]	684[a]	670	604	600	520	487	464	494	694	507
Drugs	962	651[a]	513[a]	494	444	347	292	271	226	208	202	186
Other chemicals	456	348[a]	321[a]	310	284	221	188	187	182	174	147	148
Other industries	**36,954**	**27,897[a]**	**21,760[a]**	**19,280**	**17,539**	**16,400**	**15,563**	**14,388**	**13,446**	**13,158**	**13,568**	**12,862**
TOTAL	**$39,477**	**$29,843**	**$23,278**	**$20,752**	**$18,869**	**$17,562**	**$16,562**	**$15,333**	**$14,318**	**$14,034**	**$14,413**	**$13,703**

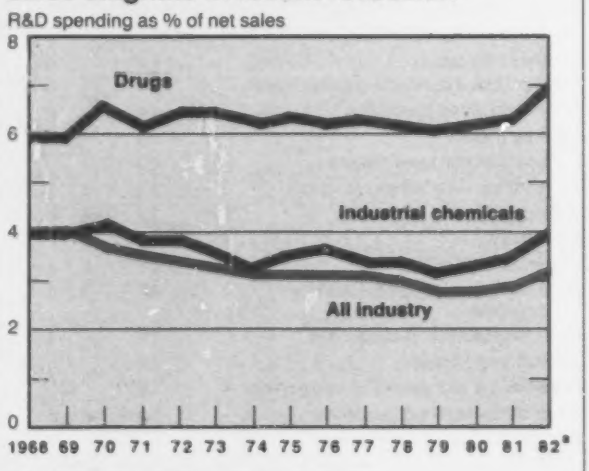
a Estimates. **Note:** No data for 1978 and 1980. **Source:** National Science Foundation

Chemical industry keeps R&D outlays ahead of inflation



a C&EN estimates. Source: National Science Foundation

R&D's share of industry sales rises as sales stagnate in recent recession



a C&EN estimates. Source: National Science Foundation

APPLIED R&D BY ALL INDUSTRY ON CHEMICALS: Biggest share devoted to drugs

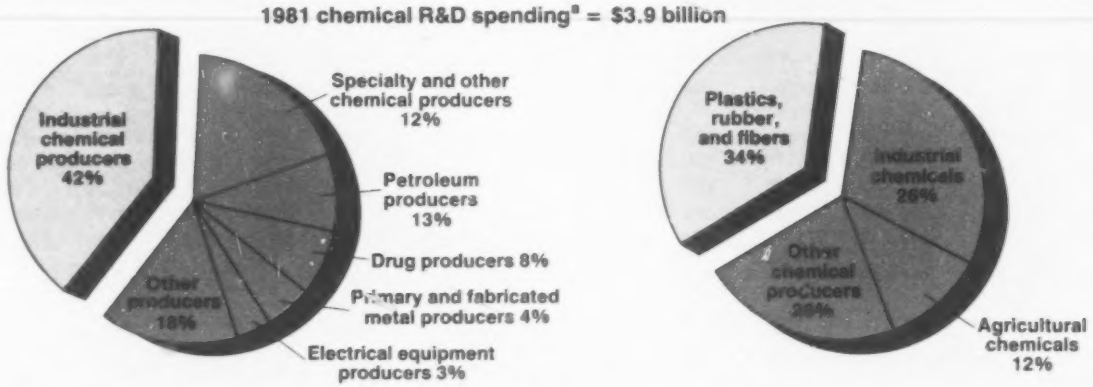
$ Millions	1981	1979	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968
Industrial Chemicals	$1020	na	$ 822	$ 728	$ 665	$ 589	$ 489	$ 451	$ 457	$ 442	$ 417	$ 396
Plastics, rubber, and fibers	1315	$ 881	747	674	588	589	511	453	511	521	482	466
Agricultural chemicals	487	292	236	205	176	137	114	108	130	126	104	99
Other chemicals	1081	na	220	246	198	248	229	238	218	223	210	207
Drugs	1837	1089	959	883	783	683	605	531	535	474	417	375
TOTAL	**$5740**	**$3648**	**$2984**	**$2736**	**$2410**	**$2246**	**$1948**	**$1781**	**$1851**	**$1786**	**$1630**	**$1543**

na = not available. **Note:** No data for 1978 and 1980. **Source:** National Science Foundation

Industrial chemical producers do more than 40% of R&D on chemicals . . .

. . . and biggest slice of chemical R&D involves polymers

1981 chemical R&D spending[a] = $3.9 billion


Industrial chemical producers 42%
Specialty and other chemical producers 12%
Petroleum producers 13%
Drug producers 8%
Primary and fabricated metal producers 4%
Electrical equipment producers 3%
Other producers 18%
Plastics, rubber, and fibers 34%
Industrial chemicals 26%
Other chemical producers 28%
Agricultural chemicals 12%

a Excludes basic research and research on drugs. **Source:** National Science Foundation

APPLIED R&D ON CHEMICALS AND DRUGS: Outside chemical industry, oil firms do most

	Product field ($ millions)									
	1981		1979		1977		1976		1975	
Industry	**Chemicals**	**Drugs**	**Chemicals**	**Drugs**	**Chemicals**	**Drugs**	**Chemicals**	**Drugs**	**Chemicals**	**Drugs**
Chemicals and allied products	**$2406**	**$1719**	**$1604**	**$1020**	**$1327**	**$903**	**$1192**	**$817**	**$1158**	**$681**
Industrial chemicals	918	203	1086	138	806	101	711	84	807	83
Drugs	304	1460	205	840	131	756	130	703	84	567
Other chemicals	484	55	313	42	390	46	351	30	267	31
Petroleum refining	**520**	**0**	**283**	**a**	**192**	**7**	**169**	**4**	**170**	**4**
Rubber products	**a**	**0**	**75**	**0**	**44**	**a**	**31**	**a**	**34**	**a**
Stone, clay, and glass products	**a**	**7**	**37**	**0**	**34**	**0**	**31**	**5**	**22**	**0**
Food and kindred products	**45**	**a**	**28**	**a**	**26**	**a**	**25**	**5**	**23**	**19**
Textiles and apparel	**a**	**0**	**a**	**0**	**a**	**0**	**a**	**0**	**11**	**a**
Lumber, wood products, and furniture	**15**	**0**	**5**	**0**	**10**	**0**	**8**	**0**	**8**	**0**
Paper and allied products	**46**	**0**	**36**	**0**	**22**	**a**	**13**	**a**	**16**	**a**
Primary metals	**79**	**0**	**a**	**0**	**55**	**a**	**47**	**0**	**24**	**a**
Ferrous metals and products	23	0	a	0	14	0	13	0	11	a
Nonferrous metals and products	57	0	a	0	41	a	34	0	12	0
Fabricated metal products	**79**	**0**	**65**	**a**	**47**	**3**	**42**	**4**	**20**	**6**
Machinery	**92**	**0**	**26**	**0**	**24**	**a**	**15**	**a**	**28**	**a**
Electrical equipment	**124**	**a**	**62**	**a**	**49**	**4**	**56**	**6**	**50**	**a**
Motor vehicles and motor vehicle equipment	**97**	**0**	**68**	**0**	**48**	**0**	**42**	**0**	**a**	**0**
Other transportation equipment	**22**	**1**	**19**	**0**	**15**	**0**	**a**	**0**	**a**	**0**
Aircraft and missiles	**52**	**0**	**25**	**0**	**15**	**0**	**27**	**0**	**35**	**a**
Professional and scientific instruments	**a**	**100**	**65**	**54**	**43**	**35**	**37**	**30**	**31**	**42**
Other manufacturing industries	**12**	**0**	**26**	**0**	**12**	**0**	**10**	**0**	**11**	**0**
Nonmanufacturing industries	**77**	**0**	**a**	**a**	**58**	**a**	**62**	**a**	**24**	**a**
TOTAL	**$3903**	**$1837**	**$2559**	**$1089**	**$2024**	**$959**	**$1837**	**$877**	**$1703**	**$760**

a Not separately available but included in total. **Note:** No data for 1978 and 1980. **Source:** National Science Foundation

COMPANY R&D SPENDING: Most budgets have been increased this year, if only moderately

$ Millions	1983[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973
Air Products	$ 40	$ 37	$ 32	$ 30	$ 24	$ 23	$ 24	$ 19	$ 16	$ 11	$ 8
American Cyanamid	200	181	164	142	124	108	96	83	73	64	52
Celanese	100	102	104	94	92	83	77	70	64	58	49
Diamond Shamrock	46	48	53	45	37	32	26	24	20	14	12
Dow Chemical	480	460	404	314	269	232	203	188	167	149	118
Du Pont[b]	890	790	575	485	415	377	367	353	336	344	286
Ethyl	39	39	36	34	29	26	28	25	28	25	22
W. R. Grace	71	62	55	45	42	37	32	28	30	32	28
Hercules	68	71	61	53	47	40	37	35	30	30	25
Monsanto	284	256	221	204	161	136	132	114	116	87	82
Olin	48[c]	47	39	31	26	25	25	25	24	19	na
Pennwalt	34	31	27	24	22	23	21	19	16	14	13
Rohm & Haas	94[c]	92	77	67	54	49	45	43	45	39	32
Stauffer Chemical	64	62	51	44	37	34	33	29	24	20	17
Union Carbide	240	240	201	166	161	156	156	143	120	94	77
TOTAL	$2698	$2518	$2102	$1778	$1540	$1391	$1302	$1198	$1109	$1000	$821
ANNUAL CHANGE	7%	20%	18%	15%	12%	6%	9%	8%	11%	20%	5%

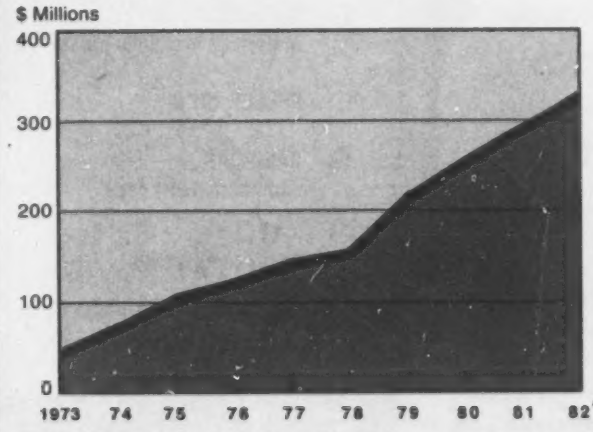
a Planned. b Excludes Conoco. c C&EN estimate. **Source:** Company data

R&D BY U.S. COMPANIES ABROAD: Chemical firms continue to boost spending outside U.S.

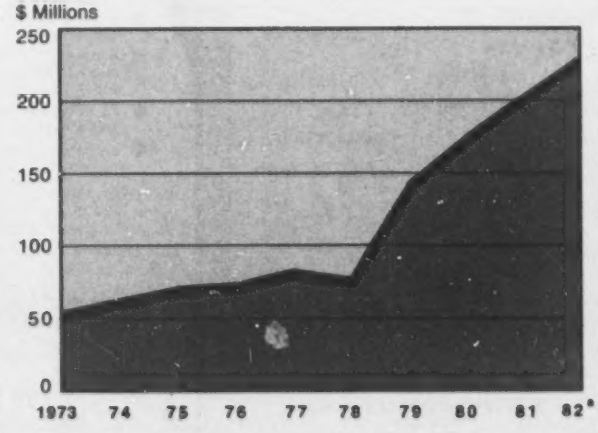
$ Millions	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	Annual change 1981–82	Annual change 1974–82
Chemicals and allied products	$ 700	$ 651	$ 603	$ 500	$ 395	$ 332	$ 312	$ 269	$ 208	8%	16%
Industrial and other chemicals	300	275	245	199	151	133	108	85	82	9	18
Drugs	400	376	357	301	244	199	204	184	126	6	16
Other industries	2600	2506	2562	2254	1814	1545	1347	1185	1092	4	11
TOTAL	$3300	$3157	$3165	$2754	$2209	$1877	$1659	$1454	$1300	5%	12%

a C&EN estimates. **Source:** National Science Foundation

Chemical industry's spending on energy R&D has tripled since 1975 . . .

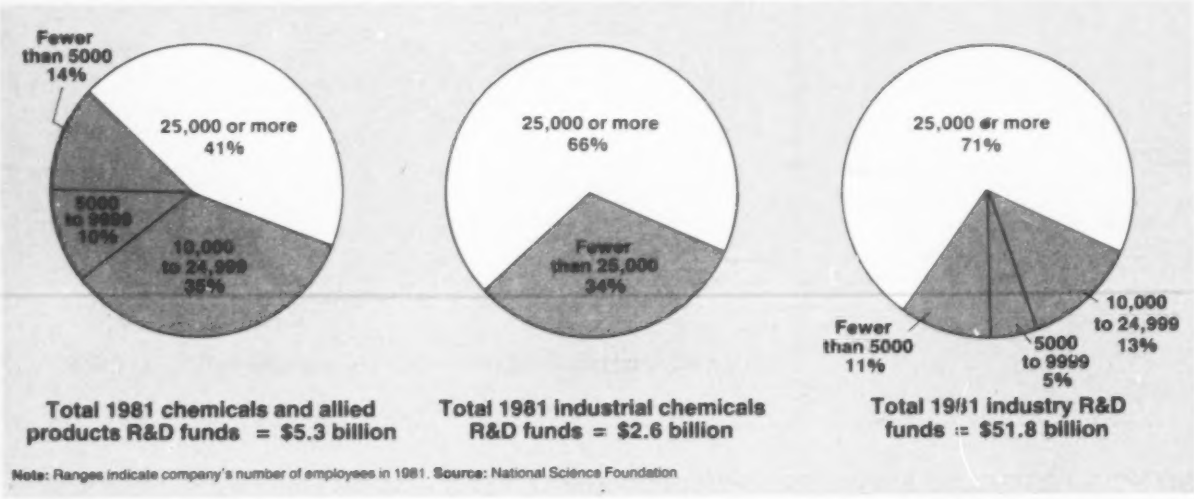


. . . as have its outlays for pollution control R&D



a C&EN estimates. **Source:** National Science Foundation

Biggest share of R&D funds is spent by companies with 25,000 or more employees



Total 1981 chemicals and allied products R&D funds = $5.3 billion

Total 1981 industrial chemicals R&D funds = $2.6 billion

Total 1981 industry R&D funds = $51.8 billion

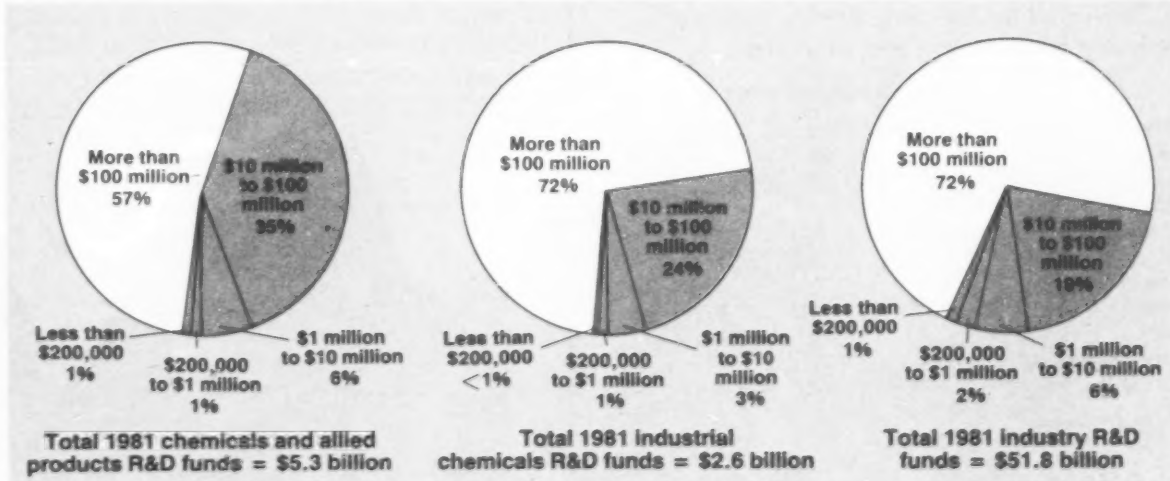
Note: Ranges indicate company's number of employees in 1981. Source: National Science Foundation

R&D SCIENTISTS AND ENGINEERS IN INDUSTRY: Big increase in 1982 for chemical industry

Thousands[a]	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
Chemicals and allied products	60.0	54.7	51.4	50.0	48.3	46.4	44.4	45.2	41.8	40.9	41.0
Industrial chemicals	24.3	21.6	20.9	21.4	21.3	20.6	20.1	21.1	19.1	19.1	19.1
Drugs	25.3	23.3	21.6	20.9	19.5	17.8	16.6	15.6	14.0	13.0	13.1
Other chemicals	10.4	9.8	8.9	7.9	7.5	8.0	7.8	8.5	8.7	8.8	8.8
Other industries	451.6	433.1	408.6	373.9	356.1	336.4	320.0	318.1	318.2	316.8	309.2
TOTAL	511.6	487.8	460.0	423.9	404.4	382.8	364.4	363.3	360.0	357.7	350.2

a Full-time equivalent. Source: National Science Foundation

More than 50% of R&D spending is by firms with budgets of more than $100 million


More than $100 million 57%
$10 million to $100 million 35%
Less than $200,000 1%
$200,000 to $1 million 1%
$1 million to $10 million 6%
More than $100 million 72%
$10 million to $100 million 24%
Less than $200,000 <1%
$200,000 to $1 million 1%
$1 million to $10 million 3%
More than $100 million 72%
$10 million to $100 million 19%
Less than $200,000 1%
$200,000 to $1 million 2%
$1 million to $10 million 6%

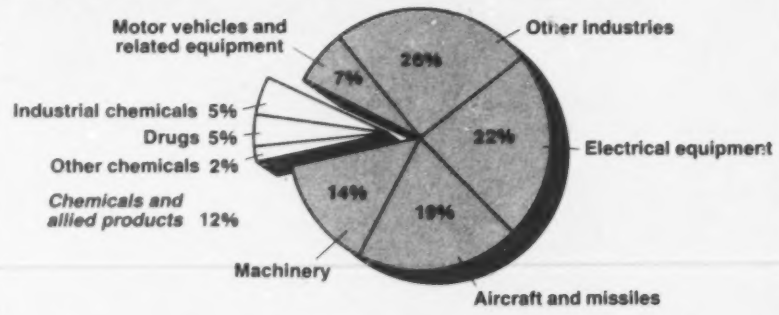
Total 1981 chemicals and allied products R&D funds = $5.3 billion

Total 1981 industrial chemicals R&D funds = $2.6 billion

Total 1981 industry R&D funds = $51.8 billion

Note: Ranges indicate size of company's 1981 R&D program. Source: National Science Foundation

Makers of electrical equipment and aircraft employ more than 40% of R&D scientists and engineers



1982 total industrial R&D scientists and engineers[a] = 511,600

a Full-time equivalent. **Source:** National Science Foundation

R&D SCIENTISTS AND ENGINEERS PER 1000 EMPLOYEES: Ratio is high for chemical firms

	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
Chemicals and allied products	**45**	**43**	**42**	**43**	**42**	**40**	**41**	**40**	**39**	**39**	**41**	**39**
Industrial chemicals	39	36	36	38	38	36	38	37	36	34	35	35
Drugs	65	62	62	65	62	64	59	57	57	60	65	65
Other chemicals	34	32	27	27	29	28	29	30	29	31	31	30
All industry	**29**	**28**	**27**	**27**	**27**	**27**	**26**	**25**	**24**	**24**	**26**	**26**

Source: National Science Foundation

COST PER INDUSTRIAL R&D SCIENTIST OR ENGINEER: Doubled in past decade

$ Thousands	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971
Chemicals and allied products	**$ 92.7**	**$ 84.8**	**$76.1**	**$71.7**	**$68.4**	**$66.5**	**$60.9**	**$56.3**	**$51.1**	**$47.1**	**$43.7**
Industrial chemicals	111.4	101.8	92.4	84.3	79.2	74.7	67.5	63.5	58.6	54.0	49.2
Drugs	a	76.3	69.9	63.8	64.4	63.4	60.9	54.3	51.5	46.5	43.2
Other chemicals	a	67.5	64.4	60.5	53.1	50.8	43.2	45.3	34.0	33.4	35.5
All industry	**103.7**	**93.9**	**86.8**	**79.9**	**76.1**	**72.2**	**66.5**	**63.3**	**59.2**	**55.3**	**51.1**

a Not separately available but included in total. **Source:** National Science Foundation

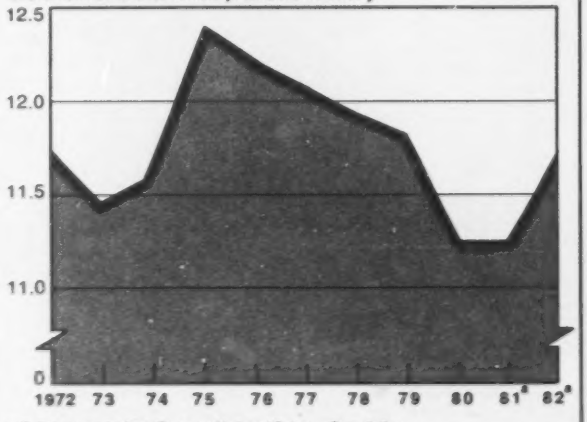
CHEMISTS IN INDUSTRY: Almost half are employed by chemical and drug firms

	% of industrial chemicals			
Industry	**All chemists**	**B.S.**	**M.S.**	**Ph.D.**
Chemical	31	25	27	38
Pharmaceutical	18	16	21	18
Petroleum	7	6	5	8
Coatings	6	9	7	4
Food	4	5	5	3
Metals and minerals	3	4	3	2
Rubber	2	4	3	1
Paper	2	1	2	2
Other manufacturing	20	22	19	19
Nonmanufacturing	7	8	8	5

Source: 1982 ACS survey

Share of scientists, engineers in chemical industry reversed six-year drop in 1982

% of total industrial R&D scientists and engineers[a] in the chemicals and allied products industry



a Full-time equivalent. **Source:** National Science Foundation

SECTION 4

R&D

Universities and colleges

Growth is modest for academic spending on R&D

Small increases in funding from government agencies make last year's rise in outlays the smallest in a decade

CHARACTER OF UNIVERSITY R&D SPENDING: Increases were small in 1982 across the board

$ Millions	1982[a]	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	Annual change 1981–82	Annual change 1972–82
Basic research	$4700	$4559	$4020	$3607	$3172	$2797	$2548	$2410	$2154	$2053	$2022	3%	9%
Applied research	1920	1857	1687	1463	1213	1068	1015	851	736	713	524	3	14
Development	390	377	343	284	236	200	164	148	133	118	84	3	17
TOTAL	**$7010**	**$6793**	**$6050**	**$5354**	**$4621**	**$4065**	**$3727**	**$3409**	**$3023**	**$2884**	**$2630**	**3%**	**10%**

a Estimated. **Source:** National Science Foundation

SOURCE OF UNIVERSITY R&D FUNDS: Only industry provided a substantial increase last year

$ Millions	1982[a]	1981	1980	1979	1978[b]	1977	1976	1975	1974	1973	1972	Annual change 1981–82	Annual change 1972–82
Federal government	$4695	$4549	$4093	$3594	$3057	$2726	$2512	$2288	$2032	$1985	$1795	3%	10%
State and local governments	548	538	493	469	413	373	363	332	307	295	269	2	7
Industry	320	285	235	193	170	139	123	113	96	84	74	12	16
Institutional funds	992	974	821	725	622	514	445	417	370	318	305	2	13
Other sources	455	447	408	373	359	313	284	259	218	202	187	2	9
TOTAL	**$7010**	**$6793**	**$3050**	**$5354**	**$4621**	**$4065**	**$3727**	**$3409**	**$3023**	**$2884**	**$2630**	**3%**	**10%**

a Estimated. b Estimated, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal year. **Source:** National Science Foundation

FIELDS OF UNIVERSITY R&D SPENDING: Outlays for chemistry have nearly tripled since 1972

$ Millions	1982[a]	1981	1980	1979	1978[b]	1977	1976	1975	1974	1973	1972	Annual change 1981–82	Annual change 1972–82
Physical sciences	**$ 785**	**$ 764.0**	**$ 676.9**	**$ 601.2**	**$ 496.4**	**$ 423.5**	**$ 379.4**	**$ 350.3**	**$ 333.5**	**$ 328.3**	**$ 324.2**	3%	9%
Chemistry	300	283.7	243.5	205.8	183.1	159.4	140.1	120.7	115.8	113.7	108.1	6	11
Physics	380	356.6	322.0	292.0	235.1	201.7	183.1	173.5	169.3	167.0	159.1	1	9
Engineering	**980**	**957.2**	**862.8**	**767.9**	**601.1**	**496.5**	**431.7**	**380.9**	**346.9**	**333.1**	**341.4**	**2**	**11**
Total R&D spending	**7010**	**6793.3**	**6049.5**	**5354.5**	**4621.3**	**4065.1**	**3727.3**	**3408.7**	**3022.6**	**2884.0**	**2630.4**	**3**	**10**

a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

FEDERALLY FINANCED R&D SPENDING AT UNIVERSITIES: Chemistry accounts for nearly 5%

$ Millions	1982[a]	1981	1980	1979	1978[b]	1977	1976	1975	1974	1973	1972	Annual change 1981–82	Annual change 1972–82
Physical sciences	**$ 635**	**$ 617.6**	**$ 554.4**	**$ 490.7**	**$ 392.3**	**$ 338.8**	**$ 305.4**	**$ 285.0**	**$ 270.2**	**$ 268.4**	**$ 261.0**	3%	9%
Chemistry	225	215.9	189.2	156.5	138.0	121.5	107.9	92.7	88.7	86.6	82.6	4	11
Physics	315	308.3	279.7	252.5	199.2	171.9	156.1	149.9	146.5	145.4	136.3	2	9
Engineering	**680**	**661.3**	**594.6**	**526.4**	**407.5**	**336.7**	**290.5**	**259.4**	**239.3**	**238.1**	**252.9**	**3**	**10**
Total R&D spending	**4695**	**4549.3**	**4092.5**	**3594.3**	**3057.2**	**2725.8**	**2511.6**	**2288.1**	**2032.2**	**1985.4**	**1795.0**	**3**	**10**

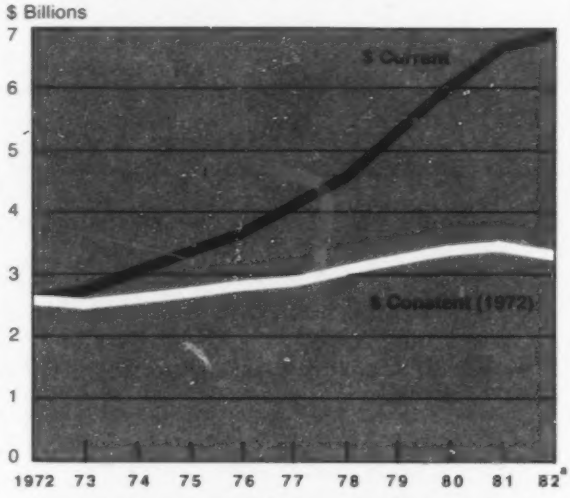
a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. **Note.** Data for institutional fiscal years. **Source:** National Science Foundation

TOP 12 UNIVERSITIES IN R&D SPENDING: Johns Hopkins leads by a large margin

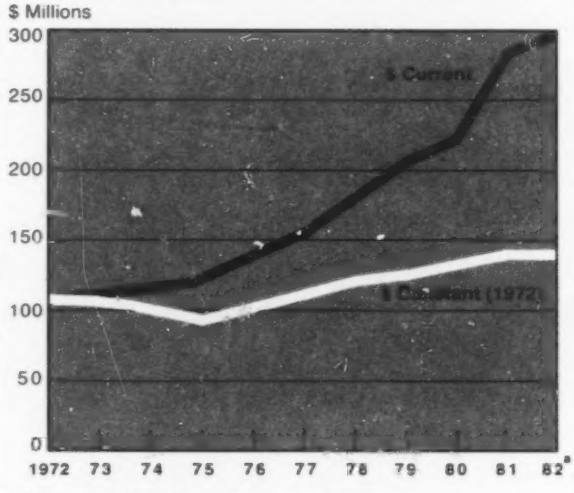
$ Millions, fiscal 1981	Physical sciences	Chemistry[a]	Engineering	Environmental sciences	Life sciences	Math and computer sciences	Other sciences[b]	Total
Johns Hopkins University	$49.6	$4.1	$64.0	$28.8	$73.2	$45.0	$ 9.9	**$270.5**
Massachusetts Institute of Technology	57.1	8.2	73.4	9.6	24.0	10.6	9.5	**184.3**
University of Wisconsin, Madison	13.4	4.1	13.2	13.9	78.6	4.8	23.7	**147.5**
University of California, San Diego	20.3	4.4	1.2	59.1	53.3	1.5	2.5	**137.8**
University of Michigan	9.5	2.0	17.6	12.2	57.8	2.4	33.5	**133.1**
University of Minnesota	8.2	4.3	12.0	2.5	99.5	1.4	9.5	**133.1**
Stanford University	19.7	5.6	41.2	2.5	52.5	7.9	5.9	**129.8**
University of Washington	6.1	1.5	6.2	16.8	77.5	2.3	16.0	**124.8**
Cornell University	19.3	4.6	18.7	3.6	70.4	2.0	9.1	**123.3**
Harvard University	14.7[c]	6.1[c]	1.8[c]	5.6[c]	76.4[c]	1.7[c]	11.5[c]	**111.7[c]**
University of Pennsylvania	10.0	3.4	4.8	0.9	65.2	4.7	18.9	**104.4**
Columbia University, main division	9.1	3.6	5.1	17.1	62.1	0.6	6.7	**100.7**

a Included in physical sciences. b Includes social sciences, psychology, and other sciences not listed separately. c Estimated. **Source:** National Science Foundation

Inflation has eroded gains in spending for all academic R&D recently . . .



. . . and chemical R&D spending, in real terms, barely held its own last year



a C&EN estimate. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

TOP 12 UNIVERSITY R&D CENTERS:[a] Physical sciences get half of total R&D funds

$ Millions, fiscal 1981	Physical sciences	Engineering	Environmental sciences	Life sciences	Total[b]
Lawrence Livermore National Lab	$356.1	$ 48.4	$30.1	$ 3.6	**$466.8**
Los Alamos National Lab	211.3	142.8	8.8	18.1	**442.1**
Jet Propulsion Lab	70.8	165.8	24.3	0	**411.4**
Argonne National Lab	81.6	148.6	60.4	20.6	**314.2**
Brookhaven National Lab	90.9	28.7	9.2	17.1	**150.8**
Lincoln Lab	28.4	102.5	0	0	**147.1**
Lawrence Berkeley Lab	75.1	11.9	23.6	20.7	**135.6**
Plasma Physics Lab	128.5[c]	0	0	0	**128.5[c]**
Fermi National Accelerator Lab	95.5	0	0	0	**95.5**
Stanford Linear Accelerator Center	66.5	0	0	0	**66.5**
National Center for Atmospheric Research	6.6	0	27.6	0	**34.2**
Ames Laboratory	12.7	6.4	0.2	0	**19.7**

a Data for university-administered federally funded R&D centers. b Includes sciences not listed separately. c Estimated. **Source:** National Science Foundation

ACADEMIC SCIENTISTS AND ENGINEERS: Total number of chemists rose to 18,200

Thousands of scientists and engineers[a]	1982	1981	1980	1978	1977	1976	1975
TOTAL							
Physical scientists	**34.4**	**34.1**	**33.6**	**32.8**	**32.1**	**31.4**	**30.8**
Chemists	18.2	18.1	17.6	17.7	17.1	16.6	16.2
Physicists	13.0	12.9	13.0	12.8	12.5	12.2	12.3
Engineers	**36.4**	**34.8**	**33.7**	**31.0**	**30.1**	**28.5**	**27.9**
Chemical	2.3	2.3	2.4	2.0	1.9	1.9	1.9
Other scientists	**278.0**	**264.6**	**256.8**	**243.8**	**235.5**	**228.3**	**220.2**
TOTAL	**348.8**	**333.4**	**324.1**	**307.6**	**297.8**	**288.2**	**278.9**
FULL TIME ONLY							
Physical scientists	**28.5**	**28.2**	**28.0**	**27.9**	**27.6**	**27.1**	**26.7**
Chemists	14.8	14.8	14.3	14.7	14.5	14.1	13.8
Physicists	11.2	11.0	11.3	11.2	11.1	10.8	10.9
Engineers	**28.0**	**27.0**	**26.5**	**24.7**	**24.1**	**22.9**	**22.6**
Chemical	1.9	1.9	1.9	1.7	1.7	1.6	1.6
Other scientists	**210.6**	**203.7**	**200.4**	**189.5**	**184.5**	**179.8**	**174.1**
TOTAL	**267.1**	**258.8**	**254.9**	**242.1**	**236.2**	**229.8**	**223.3**

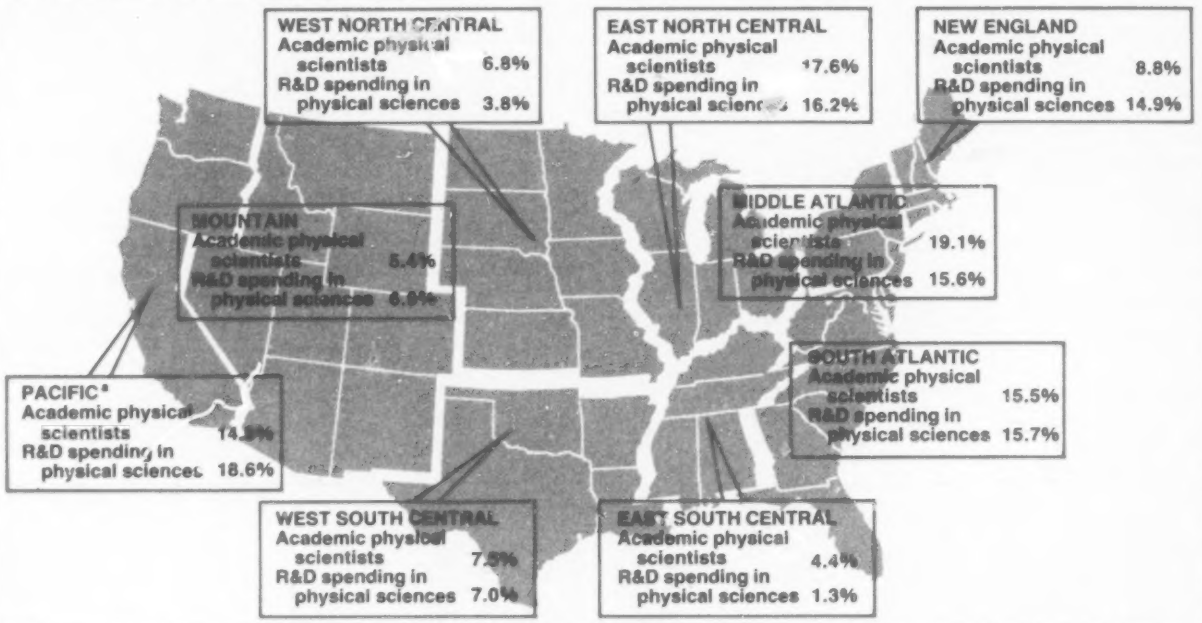
a In January. **Note:** Data not available for 1979. **Source:** National Science Foundation

SCHOOLS SPENDING MOST ON CHEMICAL R&D: About 60% of total spent by top 50 schools

$ Thousands	Total spending				Federally financed spending			
	1981	1980	1979	1978	1981	1980	1979	1978
1 Massachusetts Inst. of Technology	$ 8,222	$ 6,764	$ 5,324	$ 6,242	$ 7,572	$ 6,311	$ 5,021	$ 5,837
2 California Inst. of Technology	6,901	6,328	5,297	4,108	6,196[a]	5,630	4,813	3,712
3 U of California, Berkeley	6,553	6,022	3,717	3,046	6,008	5,601	3,485	2,758
4 Harvard U	6,123[a]	4,797[a]	4,283[a]	3,905[a]	4,637	3,631	3,241	3,396
5 Stanford U	5,564	4,788	4,159	3,549[a]	5,337	4,609	3,775	3,266
6 U of Illinois, Urbana	5,239	4,261	3,963	3,211	3,847	3,424	2,696	2,426
7 U of Texas, Austin	4,779	3,970	3,373	3,057	3,017	2,564	2,282	1,931
8 Cornell U	4,618	3,808	3,414	3,423	4,062	3,404	3,087	3,137
9 Purdue U	4,600	3,596	3,438	2,857	3,715	3,151	3,087	2,500
10 U of California, San Diego	4,430	4,425[a]	3,757[a]	3,611	3,933	4,375[a]	3,707[a]	3,293
Total, first 10 institutions	57,029	48,759	40,725	37,009	48,324	42,700	35,194	32,256
11 U of California, Los Angeles	4,420	4,159	3,573	3,236	4,127	4,017	3,379	3,052
12 U of Minnesota	4,260	2,642	2,162	1,803	3,494	2,143	1,624	1,415
13 U of Chicago	4,139[a]	3,958[a]	3,418[a]	3,113[a]	3,719	3,558	3,039	2,803
14 U of Wisconsin, Madison	4,122	3,976	3,346	5,149	3,134	2,944	2,353	2,933
15 Texas A&M U	4,069	4,097	3,715	3,261	2,793	2,945	2,361	2,243
16 Johns Hopkins U	4,066	4,652	4,064[a]	1,160	3,881	4,444	3,968[a]	1,084
17 U of Colorado	4,047	3,332	2,544	899	3,146	2,605	1,942	688
18 U of Notre Dame	3,855	3,457	[illegible]6	2,475	3,736	3,328	2,618	2,389
19 Georgia Inst. of Technology	3,660	3,655	3,577	2,784	2,030	2,118	2,110	1,551
20 Indiana U	3,637	3,147	2,644	2,236	3,042	2,635	2,306	1,959
Total, first 20 institutions	97,304	85,834	72,514	63,125	81,428	73,437	60,894	52,373
21 Columbia U, main division	3,564	4,437	3,531	3,321	3,471	4,054	3,202	2,854
22 Pennsylvania State U	3,413	2,973	2,303	1,904	2,773	2,527	1,969	1,590
23 U of Pennsylvania	3,386	3,688	2,211	1,761	3,073	3,143	1,840	1,356
24 U of Massachusetts, Amherst	3,230	1,689	2,621	2,038	2,067	1,632	1,921	1,633
25 Ohio State U	3,227	2,654	2,039	1,740	2,679	2,144	1,743	1,493
26 U of Maryland, College Park	3,109	2,766	1,907	1,975	2,418	2,292	1,628	1,690
27 U of Utah	3,076	2,611	2,290	2,754	2,720	2,373	1,949	1,909
28 Florida State U	3,012	2,791	2,478	1,490[b]	1,463	1,313	1,160	777[b]
29 Northwestern U	2,995	2,367	1,851	1,854	2,813	2,221	1,671	1,681
30 U of Rochester	2,966	2,089	2,536	2,100	2,553	1,667	2,058	1,695
Total, first 30 institutions	129,282	114,299	96,281	84,062	107,458	96,803	80,053	69,051
31 Yale U	2,781	2,023	2,107	1,444	2,609[a]	1,886	1,750	1,379
32 State U of New York, Stony Brook	2,691	1,966	1,801	1,637	2,080	1,632	1,554	1,281
33 Princeton U	2,513	2,065	2,242	1,660	2,142	1,643	1,621	1,271
34 Colorado State U	2,385	1,973	1,774	1,398	2,079	1,717	1,579	1,193
35 U of Southern California	2,345	2,313	2,181	1,676	1,639	1,773	1,731	1,381
36 U of Florida	2,302	2,283[a]	1,968	1,265	1,156	1,214[a]	1,339	1,077
37 Rensselaer Polytechnic Inst.	2,266	1,551	968	900	1,310[a]	962	680[a]	660
38 Wayne State U	2,261	2,163	2,022	2,740	1,636	1,640	1,555	1,926
39 Syracuse U	2,259	764	691[a]	382	551	396	327	295
40 Carnegie-Mellon U	2,225	2,075	1,957	3,828	1,768	1,515	1,408	1,542
Total, first 40 institutions	153,330	133,475	113,992	100,992	124,428	111,184	93,592	81,056
41 State U of New York, Buffalo	2,203	1,665	1,143	1,008	1,626	1,163	817	785
42 Michigan State U	2,178	1,638	1,491	1,262	1,541	1,157	1,049	878
43 U of Nebraska, Lincoln	2,175	2,289	1,745	1,040	1,757	1,909	983	769
44 Arizona State U	2,153	1,449	1,076	1,011	1,958	1,365	805	964
45 Case Western Reserve U	2,139	1,938	1,413	1,190	1,732	1,617	1,145	940
46 U of Pittsburgh	2,039	1,641	1,728	1,709	1,581	1,366	1,416	1,201
47 U of Michigan	2,016	2,064	1,406	1,171	1,591	1,775	1,229	982
48 U of North Carolina, Chapel Hill	2,016	1,789	1,685	1,413	1,936	1,752	1,666	1,398
49 Washington State U	1,920	1,043	785	751	946	804	673	651
50 U of California, Irvine	1,915	1,398	1,277	1,435	1,821	1,344	1,243	1,372
TOTAL, FIRST 50 INSTITUTIONS	$174,084	$150,389	$127,741	$112,982	$140,917	$125,436	$104,614	$ 90,996
NATIONAL TOTAL	$283,683	$243,798	$205,830	$183,131	$215,890	$189,228	$156,516	$138,001

a Estimated. b Imputed. **Note:** Data for institutional fiscal years. **Source:** National Science Foundation

Biggest concentration of academic physical scientists is in the Mid-Atlantic, but West Coast schools spend more on R&D in the physical sciences


WEST NORTH CENTRAL
Academic physical scientists 6.8%
R&D spending in physical sciences 3.8%
EAST NORTH CENTRAL
Academic physical scientists 17.6%
R&D spending in physical sciences 16.2%
NEW ENGLAND
Academic physical scientists 8.8%
R&D spending in physical sciences 14.9%
MOUNTAIN
Academic physical scientists 5.4%
R&D spending in physical sciences 6.0%
MIDDLE ATLANTIC
Academic physical scientists 19.1%
R&D spending in physical sciences 15.6%
SOUTH ATLANTIC
Academic physical scientists 15.5%
R&D spending in physical sciences 15.7%
PACIFIC[a]
Academic physical scientists 14.3%
R&D spending in physical sciences 18.6%
WEST SOUTH CENTRAL
Academic physical scientists 7.5%
R&D spending in physical sciences 7.0%
EAST SOUTH CENTRAL
Academic physical scientists 4.4%
R&D spending in physical sciences 1.3%

Key to map: Using the Middle Atlantic states as an example, 19.1% of all physical scientists employed at U.S. universities and colleges are located in this geographical area and 15.6% of all R&D expenditures in the physical sciences by universities and colleges are in this area. a Includes Alaska and Hawaii. **Note:** Data are based on 33,966 physical scientists employed at universities and colleges in the U.S. as of January 1982, and R&D expenditures of $762.9 million in the physical sciences during these institutions' 1981 fiscal year. Data exclude universities and colleges in outlying areas. **Source:** National Science Foundation

CHEMICAL DEGREES: Engineering degrees up 2%; those in chemistry down 1% in 1981

Academic year	Degrees awarded in chemistry[a]			Degrees awarded in chemical engineering		
	Bachelors	Masters	Ph.D.s	Bachelors	Masters	Ph.D.s
1965–66	9,735	1839	1571	2848	994	354
1966–67	9,872	1831	1744	2869	949	305
1967–68	10,847	2014	1757	3211	1156	367
1968–69	11,807	2070	1941	3557	1136	409
1969–70	11,617	2146	2208	3720	1045	438
1970–71	11,183	2284	2160	3615	1100	406
1971–72	10,721	2259	1971	3663	1154	394
1972–73	10,226	2230	1882	3636	1051	397
1973–74	10,525	2138	1828	3454	1045	400
1974–75	10,649	2006	1824	3142	990	346
1975–76	11,107	1796	1623	3203	1031	308
1976–77	11,322	1775	1571	3581	1086	291
1977–78	11,474	1892	1525	4615	1237	259
1978–79	11,643	1765	1518	5655	1149	304
1979–80	11,446	1733	1551	6383	1271	284
1980–81	11,347	1654	1622	6527	1267	300

a Does not include biochemistry and geochemistry. **Source:** Department of Education's National Center for Education Statistics

GRADUATE SCIENCE STUDENTS: Enrollment in chemical sciences grows moderately

Thousands	1981	1980	1979	1978	1977	1976	1975
TOTAL							
Physical sciences	**25.8**	**25.4**	**24.9**	**24.7**	**24.9**	**24.8**	**24.6**
Chemistry	15.3	15.1	14.9	14.8	14.6	14.4	14.1
Physics	9.9	9.6	9.3	9.2	9.5	9.7	9.7
Engineering	**77.0**	**72.3**	**68.9**	**65.8**	**65.8**	**64.2**	**64.6**
Chemical	6.5	6.1	5.6	5.3	5.2	5.2	5.1
Metallurgical and materials	3.0	2.8	2.6	2.5	2.5	2.3	2.3
Petroleum	0.5	0.5	0.4	0.4	0.4	0.4	0.3
Biological sciences	**41.3**	**42.1**	**42.1**	**42.7**	**42.7**	**41.6**	**40.6**
Biochemistry	3.9	3.8	3.8	3.9	3.8	3.7	3.7
Other sciences[a]	**196.1**	**193.9**	**184.7**	**176.6**	**173.1**	**167.5**	**163.9**
TOTAL	**340.2**	**333.7**	**320.5**	**309.8**	**306.5**	**298.1**	**293.6**
FULL TIME ONLY							
Physical sciences	**22.6**	**22.3**	**21.8**	**21.5**	**21.8**	**21.6**	**21.3**
Chemistry	13.2	13.1	12.8	12.7	12.6	12.4	12.0
Physics	8.8	8.5	8.3	8.2	8.5	8.5	8.5
Engineering	**45.4**	**42.5**	**39.8**	**37.4**	**37.1**	**36.5**	**37.1**
Chemical	5.1	4.6	4.3	4.0	4.0	3.8	3.6
Metallurgical and materials	2.4	2.2	2.1	1.9	1.9	1.8	1.8
Petroleum	0.4	0.4	0.3	0.3	0.3	0.3	0.2
Biological sciences	**34.9**	**35.3**	**35.3**	**35.5**	**35.8**	**35.2**	**34.5**
Biochemistry	3.6	3.6	3.5	3.6	3.5	3.4	3.4
Other sciences[a]	**131.6**	**130.6**	**126.5**	**122.1**	**122.8**	**120.7**	**117.3**
TOTAL	**234.5**	**230.6**	**223.4**	**216.6**	**217.4**	**214.1**	**210.3**

a Includes environmental, mathematical, computer, health, agricultural, and social sciences and psychology. **Note:** Data for Ph.D.-granting institutions only. **Source:** National Science Foundation